



MODEL ENGINEERS' WORKSHOP

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SEPTEMBER 2015

INSIDE
Workshop Photo
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Winners



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ON DISPLAY**

**THE 3D
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PROJECT**
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MODEL ENGINEERS' WORKSHOP

Published by MyTimeMedia Ltd.
Enterprise House, Enterprise Way,
Edenbridge, Kent TN8 6HF

Tel: 0844 412 2262

From outside UK: +44 (0)1689 869840
www.model-engineer.co.uk

SUBSCRIPTIONS

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Model Engineers' Workshop, ISSN 0959-6909, is published monthly with an additional issue in August by MYTIMEMEDIA Ltd, Enterprise House, Enterprise Way, Edenbridge, Kent TN8 6HF, UK. The US annual subscription price is 52.95GBP (equivalent to approximately 88USD). Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Periodicals postage paid at Jamaica NY 11431. US Postmaster: Send address changes to Model Engineers' Workshop, Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Subscription records are maintained at CDS GLOBAL Ltd, Tower House, Sovereign Park, Market Harborough, Leicestershire, LE16 9EF. Air Business Ltd is acting as our mailing agent.



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On the Editor's Bench

Get Your Motor Running

Following the inevitable results of a failed cambelt, I've had plenty of time to reflect on mass-produced engineering practice while effectively rebuilding the head of a 16-valve engine. The first, and unsurprising, point is that modern engines are not built for the convenience of those carrying out maintenance. Back in the 80s I carried out a similar exercise on my Cortina with the assistance of my dad. We had the head off, replaced a few valves and back on in an afternoon. It took me a whole day to get the head of a modern car off, what with figuring out how to disconnect everything. It didn't help that the LPG injectors completely obscured about half of the inlet manifold fixings – eventually I discovered the manifold was split, or I might still be trying now!

More profound, was seeing how the design simplified manufacture. Where a particular finish was needed, there it was, but non-bearing or sealing surfaces were milled to a very ordinary finish, or left as cast. The camshafts and valves run in the alloy of the head, no inserts, and without any sign of wear despite being a healthy age. The head itself was designed so that the bearings could be line-bored in-situ, but this leaves semi-circular cutouts that need sealing. The solution? Half-round 'lumps' on the head-cover gasket!

My ancient valve spring compressor was totally unsuitable for this 'cam in head' design, so I duly purchased a new pattern one for squeezing valve springs in holes. I hadn't realised that there are 'valves in holes' and 'valves in deep holes' and even the new device wouldn't reach. I resorted to welding in some inch-long extensions – a tip for jobs like this which involve welding small fiddly parts is to clamp the work to a piece of aluminium, say 3mm thick. The steel won't stick to it, and you can be sure of getting everything straight. Of course the irony was that, if I had turned up a steel ring, I could have modified my old spring compressor for little more effort.



Watching the Wheels Go Round

Many readers will recognise Ted Jolliffe but for those to whom the name is less familiar, Ted is a former editor of *Model Engineer*. Ted's tenure ran from the late 80s to retirement in the late 90s. Perhaps my favourite tale from Ted's *Smoke Rings* was when he was testing tyres made from RTV (room temperature vulcanising) rubber by pulling along a device fitted with a suitable wheel as he walked the dogs each evening. I am sure this must have cemented his reputation as the local eccentric, if nothing else! In the last twenty years or so there have been further developments in this area, I'm aware of Alex du Pré's technique for making pneumatic tyres. I'm sure many readers would be interested in an article on moulding RTV rubbers – if you might be able to write one, please get in touch.



Rust Bucket

No, I'm not still going on about my car! I've been sent a sample of a new rust remover that works in a different way from the more usual acid based and electrolytic approaches that have been discussed in articles and Scribe a Line over the past year. The photo shows a rather rusty towball and my stepson's 'Fat Max' metal shears ready for treatment. I will be interested to see how they respond to this treatment – I will report back next month.

CNC in the Workshop

May readers who use computerised machinery will be pleased to see the return of Marcus Bowman's *CNC in the Workshop*. Next month Marcus will be looking at the manufacture of some motorcycle heel guards, with the accent on being how to develop a workflow to tackle flowing, rather than regular, curves. In the light of feedback that many readers would prefer not to see long computer listings in the magazine, the programs that accompany the series will be available to download from Marcus' website. Full details will accompany the article.

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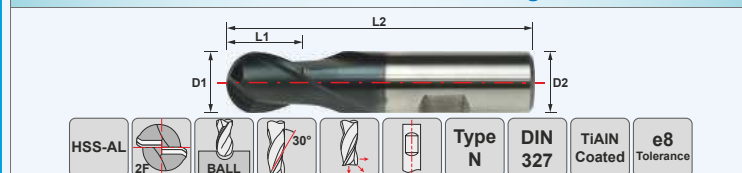
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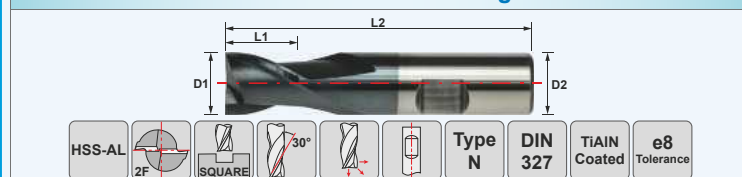
HSS-AL end mills are suitable for cutting copper, brass, iron, aluminium, hard steel and stainless steel at higher cutting rates compared to more conventional high speed steels. They also stay sharp longer and are suitable for general or heavy duty production applications.

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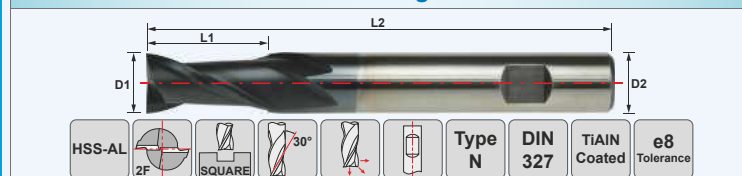
Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
060-283-03002	2.0mm	6.0mm	4mm	48mm	£7.80
060-283-03003	3.0mm	6.0mm	5mm	49mm	£7.80
060-283-03004	4.0mm	6.0mm	7mm	51mm	£7.80
060-283-03005	5.0mm	6.0mm	8mm	52mm	£7.80
060-283-03006	6.0mm	6.0mm	8mm	52mm	£7.80
060-283-03008	8.0mm	10.0mm	11mm	61mm	£9.50
060-283-03010	10.0mm	10.0mm	13mm	63mm	£9.50
060-283-03012	12.0mm	12.0mm	16mm	73mm	£11.30
060-283-03014	14.0mm	12.0mm	16mm	73mm	£12.60
060-283-03016	16.0mm	16.0mm	19mm	79mm	£14.60

2 Flute HSS-AL End Mill Standard Length TiAIN Coated



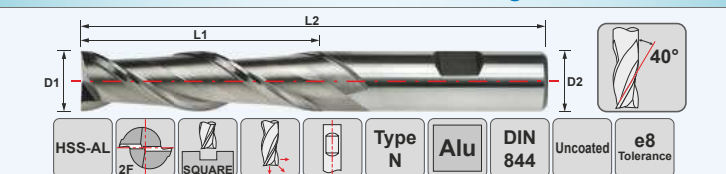
Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
060-283-01002	2.0mm	6.0mm	4mm	48mm	£5.90
060-283-01003	3.0mm	6.0mm	5mm	49mm	£5.90
060-283-01004	4.0mm	6.0mm	7mm	51mm	£5.90
060-283-01005	5.0mm	6.0mm	8mm	52mm	£5.90
060-283-01006	6.0mm	6.0mm	8mm	52mm	£5.90
060-283-01008	8.0mm	10.0mm	11mm	61mm	£8.30
060-283-01010	10.0mm	10.0mm	13mm	63mm	£8.30
060-283-01012	12.0mm	12.0mm	16mm	73mm	£9.95
060-283-01014	14.0mm	12.0mm	16mm	73mm	£11.15
060-283-01016	16.0mm	16.0mm	19mm	79mm	£12.95

2 Flute HSS-AL End Mill Long Series TiAIN Coated



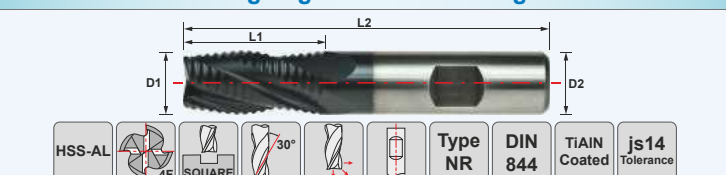
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060-283-02002	2.0mm	6.0mm	7mm	54mm	£6.90
060-283-02003	3.0mm	6.0mm	8mm	56mm	£6.90
060-283-02004	4.0mm	6.0mm	11mm	63mm	£6.90
060-283-02005	5.0mm	6.0mm	13mm	68mm	£6.90
060-283-02006	6.0mm	6.0mm	13mm	68mm	£6.90
060-283-02008	8.0mm	10.0mm	19mm	88mm	£9.70
060-283-02010	10.0mm	10.0mm	22mm	95mm	£9.70
060-283-02012	12.0mm	12.0mm	26mm	110mm	£12.50
060-283-02014	14.0mm	12.0mm	26mm	110mm	£13.90
060-283-02016	16.0mm	16.0mm	32mm	123mm	£16.00

2 Flute HSS-AL End Mill For Aluminium Long Series Uncoated



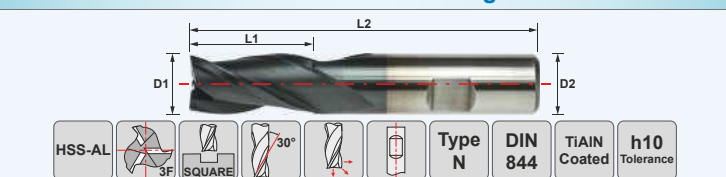
Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
060-283-07006	6.0mm	6.0mm	24mm	68mm	£6.00
060-283-07008	8.0mm	10.0mm	38mm	88mm	£7.50
060-283-07010	10.0mm	10.0mm	45mm	95mm	£7.50
060-283-07012	12.0mm	12.0mm	53mm	110mm	£8.95
060-283-07014	14.0mm	12.0mm	53mm	110mm	£10.20
060-283-07016	16.0mm	16.0mm	63mm	123mm	£12.65

4 Flute HSS-AL Roughing End Mill Std. Length TiAIN Coated



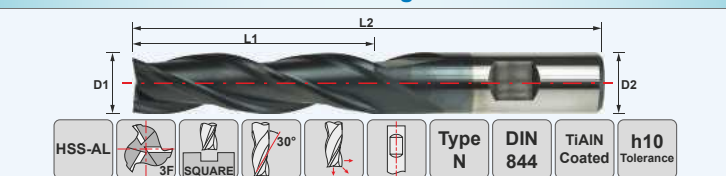
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060-283-06008	8.0mm	10.0mm	19mm	69mm	£10.30
060-283-06010	10.0mm	10.0mm	22mm	72mm	£10.30
060-283-06012	12.0mm	12.0mm	26mm	83mm	£12.30
060-283-06014	14.0mm	12.0mm	26mm	83mm	£13.75
060-283-06016	16.0mm	16.0mm	32mm	92mm	£16.25

3 Flute HSS-AL End Mill Standard Length TiAIN Coated



Code	Cutter Diameter D1	Shank Diameter D2	Flute Length L1	Overall Length L2	Price
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060-283-04005	5.0mm	6.0mm	13mm	57mm	£6.80
060-283-04006	6.0mm	6.0mm	13mm	57mm	£6.80
060-283-04008	8.0mm	10.0mm	19mm	69mm	£8.50
060-283-04010	10.0mm	10.0mm	22mm	72mm	£8.50
060-283-04012	12.0mm	12.0mm	26mm	83mm	£10.30
060-283-04014	14.0mm	12.0mm	26mm	83mm	£11.60
060-283-04016	16.0mm	16.0mm	32mm	92mm	£13.60

3 Flute HSS-AL End Mill Long Series TiAIN Coated



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060-283-05003	3.0mm	6.0mm	12mm	56mm	£7.20
060-283-05004	4.0mm	6.0mm	19mm	63mm	£7.20
060-283-05005	5.0mm	6.0mm	24mm	68mm	£7.20
060-283-05006	6.0mm	6.0mm	24mm	68mm	£7.20
060-283-05008	8.0mm	10.0mm	38mm	88mm	£9.70
060-283-05010	10.0mm	10.0mm	45mm	95mm	£9.70
060-283-05012	12.0mm	12.0mm	53mm	110mm	£11.80
060-283-05014	14.0mm	12.0mm	53mm	110mm	£13.85
060-283-05016	16.0mm	16.0mm	63mm	123mm	£16.00

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Coming up...

in the Autumn issue



SULTAN OF SWING

A swing tool is rarely seen in modern workshops, but it still has its uses. Bill Morris describes what it is and how to make and use one.

PLUS

The return of *CNC in the Home Workshop* sees Marcus Bowman making a pair of motorcycle heel guards, Bill Morris describes a swing tool and Mark Noel continues our theme of mill modification and restoration by detailing improvements to his Myford VMB.

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ON THE COVER



Apprentice Mat busy in Polly Model Engineering's workshop. Equipped with everything from pillar drills to huge CNC machines, read more on page 24.



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> Helical Gears – Theory and Practical

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> My Little Engine

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> Arduino Uses

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An Unexpected Interlude



John Pace takes a short diversion to repair a tricky gear.

Whilst doing some cylindrical grinding the drive for the work head gearbox suddenly gave up. These things almost always happen at the most inconvenient moment, the gearbox in question is a made unit, as is the rest of the machine and has been in operation for about a year now without problems.



The damaged tufnol gear.



Hobbing the replacement gear from bronze.



Hobbing the 9 tooth pinion.

At first I thought that one of the gears that I had made had stripped a tooth. As one of these gears had been made from tufnol, I had suspected that it would be this one. Dismantling the gearbox I found that all of the gears were intact so I looked at the drive motor unit, this too has an integral gearbox. This Como drills motor and gearbox unit has a 16:1 reduction gearbox. I have used these motors on other projects and they have performed well, they are good value well made and not very expensive so I was surprised that it had failed. Dismantling this gearbox revealed that the first pair in the train, also a tufnol gear, had failed. As can be seen in **photo 1** the tufnol gear has lost several teeth. The reasons for this will never be known and the remedy is either to buy a new motor/gearbox or to repair the existing one. Replacing the motor could well result in the same thing happening again later on, so having the necessary equipment to hand I decided to repair the broken gears.

Measuring the broken gear which is 25 tooth 0.5 module 20 degree pressure angle and 15 degree helix angle revealed this to have been made undersize, as at this size

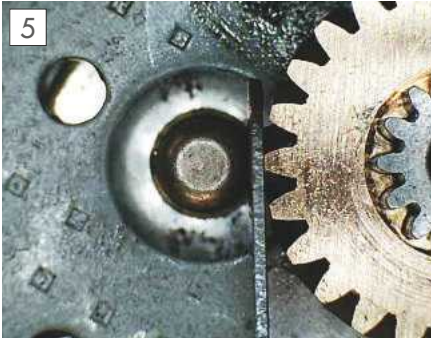
it would normally have been 13.94mm. The gear measured as 13.51mm, the reason for this becomes clearer when the centre distance from the drive pinion is measured. The output shaft of the motor is 0.125 inch diameter and when measuring there is only 0.025 inch between the top of the tooth of the 25 tooth gear and the shaft, this leaves a very thin amount below the root of the driving pinion. This would in normal practice be unacceptable, but for this low power application it is okay.

Obviously this meant trying to find a pair of gears that would fit from the usual outlets would be unlikely. Having decided on this route I decided to make a stronger set of gears to replace the brass and tufnol set. **Photograph 2** shows the new bronze gear being hobbed and the mating pinion in **photo 3**, I took the opportunity to change the existing ten tooth pinion to a nine tooth replacement as at this size there is no undercutting on the tooth form. As can be seen in photo 3 the round steel bar is held in a chuck, for these small size gears it is easier to turn the bore and then to check and clock in if needed in the hobbing unit and then part off the finished gear. The 25 tooth bronze gear was made first,

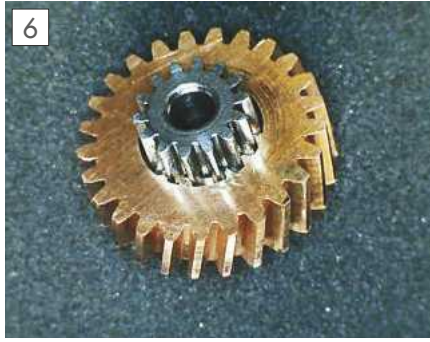
photo 4 shows the new gear with the pinion that makes the cluster and the old tufnol gear alongside. The calculation for this gear is derived by assembling the plate that holds the new bronze gear to the driving motor and using a feeler gauge to measure the distance from the shaft to the top of the teeth of the new gear, **photo 5** shows the 0.025 inch feeler gauge in position. Since the gap is 0.025 inch and the shaft diameter is 0.25 inch and the



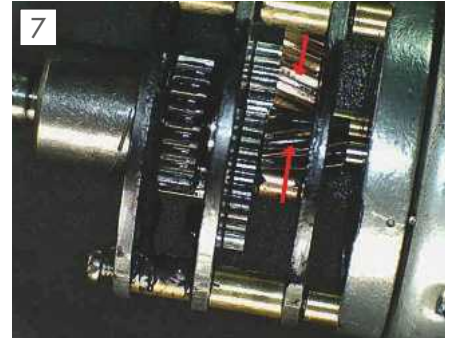
The new 25 tooth gear and the damaged tufnol gear, the pinion in the centre is pressed into the new gear to form the cluster.



Using a feeler gauge to measure the size of the new pinion.



The new 25 tooth gear assembled with the old pinion.



The new gears assembled into the motor gearbox.

addendum is 0.5mm or 0.0197 inch, adding half the shaft diameter to 0.025 and 0.0197 x 2 gives a PCD of 0.214 inch, add on the addendum of 1 mm or 0.039 inch = 0.253 inch. From here this can be a little trial and error I took off 0.003 inch to allow for some clearance and cut the gear from this size, the gear fitted in first time although the time to make a replacement at this size in material and effort is small, hobbing allows small adjustments to be made to the size of gear to ensure the best fit, although the size moves away from the technically correct gear the form will be correct and the gears will run well together.

The pinion was given a single dose of Kasenit and plunged in water to give a thin case hardened surface and fixed to the motor shaft with high strength Loctite. The original pinion was also fixed in the new 25 tooth gear with Loctite as seen in **photo 6**.

Photograph 7 shows the new gears in place indicated by the red arrows.

Photograph 8 is of the reassembled motor ready to fit back into the main gearbox.

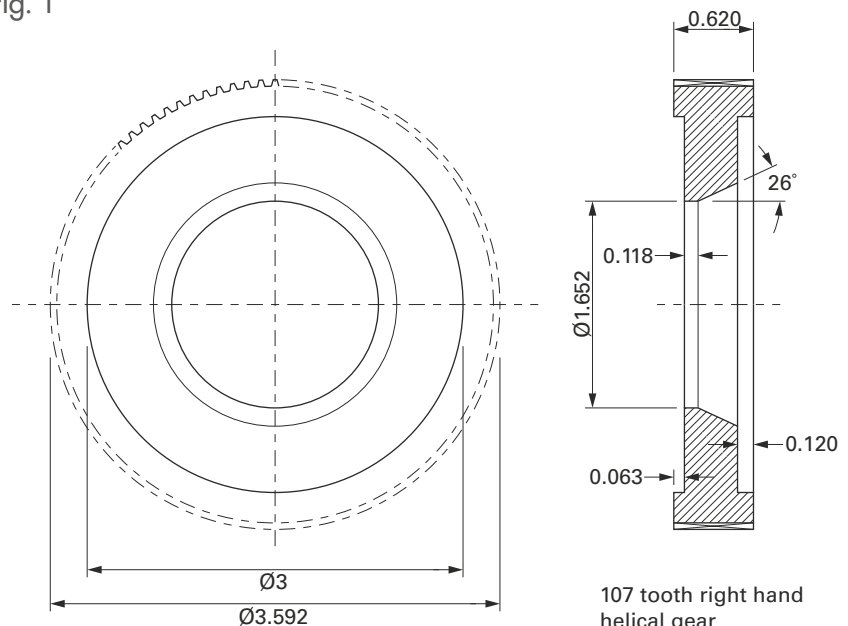
Whilst the hobbing unit was set up I felt that it was an opportunity to make something that had been on my list of jobs for some while, to make a spare gear for the Align power drive fitted on my mill. I had seen in the past some discussion on the forum about spare gears for one of these units. A quick measure up of the existing gear to get the basic dimensions, I have included a sketch of this (**fig. 1**). The serial number on my unit is AL 99SP. As far as I can recall from the forum thread the gear had 107 teeth, I only counted 106 on mine. As far as I could tell the gear is 0.8 module but could be 32 dp as these are practically the same. Looking in Ivan Law's book gears and gear cutting lists the linear pitch of 0.8 mod as .0989 inch and 32 DP as .0982 inch as can be seen they are very close and it is unlikely that many model engineers would be able to measure the difference. The choice for me was made as I only have a 0.8 module hob. Careful measurement of the helix angle revealed this to be 17.5 degrees. At 106 teeth and 0.8 mod the gear should be 90.51mm OD, at 107 tooth the OD would be 91.35mm, as measured the original gear is 91.24mm. Since the objective is to make a replacement the new gear was made the same size as the original.

Photograph 9 shows the original gear and replacement blank made from cast nylon 6-MoS₂ filled from RS components. The hub unit on the assembly is some form of clutch although this is very tight in action, it obviously works as there are some visible markings on the tapered portion of the cone, at a guess this



The motor assembly ready to fit into the main gearbox.

Fig. 1



Align Power Feed Gear
Mat'l: Cast nylon 6, MoS₂ filled

107 tooth right hand
helical gear
0.8 module
Helix angle 17.5°
PCD 3.534in



The new Align gear blank alongside the original gear and hub parts.



Hobbing the new Align gear.



The new gear alongside the old one.



The new gear fitted in the Align power feed.

provides some protection for the gear if the traverse is run into a stop at speed. Some care is needed to replicate the taper and fitting on the new gear so that the hub fits in the same position and the wavy washer and circlip will fit and provide the correct loading. The taper is turned to suit the hub and the central web is left a little on the thick side and adjusted later using the old gear for reference.

Photograph 10 shows the blank mounted on the mill being hobbled, the work is set pointing down at 17.5 deg to cut the gear. This hobbing unit (**ref 1**) was in a previous article in MEW 193, showing various types of gears being cut. A similar electronic system is described in MEW 108 by Brian Thompson. When the gear is cut a reasonable comparison as to the depth of cut is made by using a single piece of wire ($\frac{1}{16}$ welding wire) placed between the teeth and measuring the diameter of the gear across the wire and comparing this with the original gear. **Photograph 11** shows the original gear and the new cut gear; I must have mis-counted as it seems that it is 107 teeth! Being hobbled it has made no difference as it still fits in place and runs smoothly (**photo 12**). The only effect to the gear is that the tooth is slightly thicker at the root which may make it stronger, also seen here the original feed rate control pot is disconnected, a new replacement multi turn pot is indicated by the white arrow.

This is a much better arrangement together with the locking bezel provides an easier and more reliable speed control. The slot in the mounting bracket behind the arrow has a drive gear linked to the leadscrew, a clutch on the leadscrew drive can disconnect the power feed from the leadscrew to just drive a table accessory or both for spiral milling.

Hobbing provides an easy route to producing good quality gears in the home workshop. Of course there is the work involved and cost in making the parts for a hobbing unit, but in the five years since I made this at a guess I have made around about a hundred or so gears at about a conservative £10 each to buy. The unit has long since paid for itself, the two wormwheels the large one is 1.25 mod

and the small 1.0 mod seen in **photo 13** for a future cnc dividing project are over £120 for the pair from a well known gear manufacturer. With this gear cutting interlude over, back to the grinding job (**photo 14**). ■



A 75 tooth 1.25 module wormwheel and a 1 module 45 tooth wheel.



The gearbox repaired - back to the grinding.

REFERENCE

1. Richard Bartlett, Compucut. Synchron gear Hobbing system, Compucut Cnc system and Cnc machines. T. 02476 473851 www.compucutters.com

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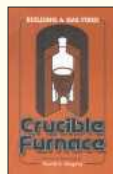
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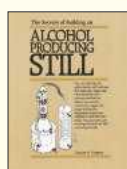
We have sold thousands of books on making your own furnace so that you can melt metal, but all of them assume you will purchase a crucible for use with it. Now Vince Gingery has written a book on making your own crucibles. Two methods are described - both depend on making molds, but differ as to how these are used. Either way looks straightforward - our guess is that the second method, involving concrete molds and some ancillary presses, is probably the best if you melt a lot of metal, and need a lot of crucibles. Covers making the clay for the crucible, firing it etc, and making crucible tongs. Excellent instruction. 117 photos and drawings. Paperback.



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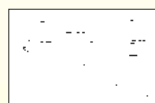
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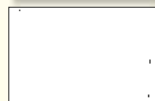
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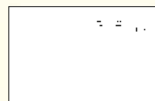
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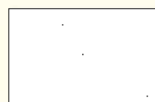
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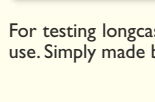
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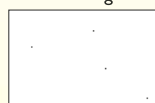


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MODEL ENGINEERS'
WORKSHOP

25th Anniversary Photography Competition

The subject for this competition could be anything that reflected what the photographer achieves in their home workshop. The challenge was to take a picture that captures the spirit of home workshop engineering, rather than just documenting a tool or a process. Initially, entries were a bit slow but eventually the very round figure of fifty entries were received. There seemed to be a fair degree of reluctance to show people actually at work in the shop, with a couple of honourable exceptions. Many entrants went for an almost 'still life' approach, whether that was a photo of a tool or a more abstract image.

The Prizes

The prizes for first, second and third place were all donated by Arc Euro trade. If you are unlucky enough not to be among the prizewinners, they are all obtainable from <http://www.arceurotrade.co.uk>



2



First prize of high-precision engineers' level from Arc EuroTrade goes to Ian Carney for 'Entropy' (photo 1) which captures the flavour of his workshop with excellent depth of field. Andrew Johnston wins second prize of a deluxe deburring set, comprising a telescopic handle and fifteen different accessories for a fine action shot (photo 2). Third prize winner is Brian Moseley who wins a handy 4 inch/100mm digital caliper for his moodily lit milling machine (photo 3).

3



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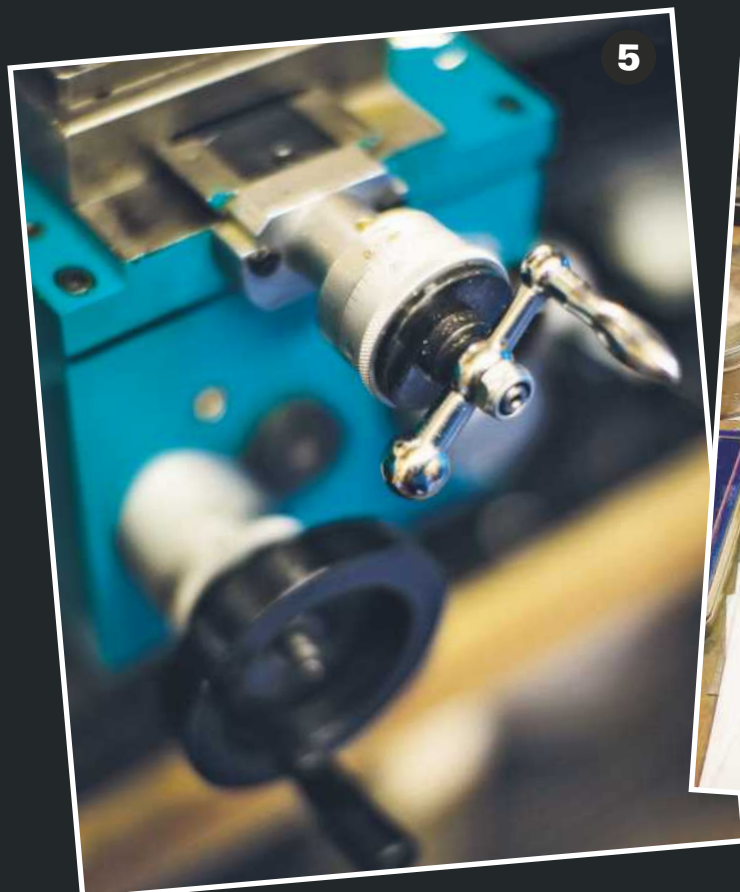
Runners Up...

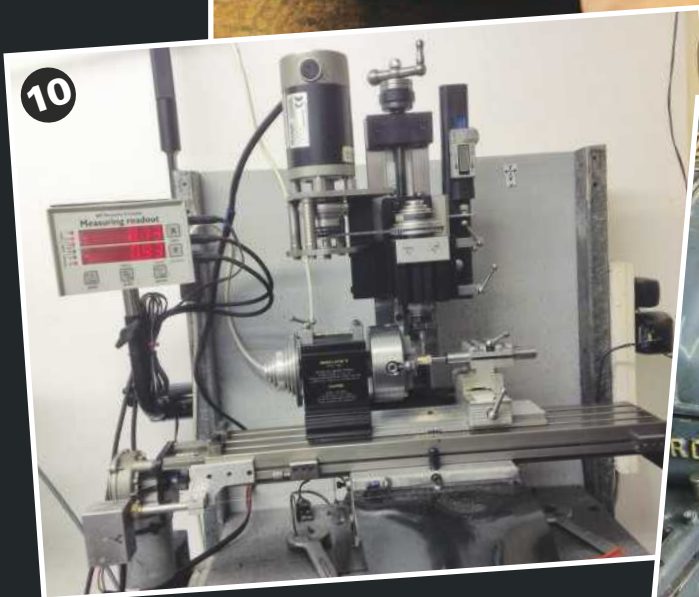
The eight runners up aren't presented in a particular order: Gary Ayre's 'nicely handled' benefits from a splash of out-of-focus colour (**photo 4**). Steve Giles also went for a depth of field effect to make the everyday interesting (**photo 5**). Henk Salij's bench features a non-compression engine, and hints at all the various stages in modelmaking (**photo 6**).

Peter Wilton's grand-daughter 'Fran in the Workshop' showed true concentration as a youngster, she is now a grown-up jewellery designer (**photo 7**). Stewart Hart deserves recognition for an impressive curl of swarf (**photo 8**). Mark Noel's 'Multigrind' scores on sheer ingenuity (**photo 9**). Peter Farmer's 'TAIG Modifications' shows just how far one can go in upgrading machine tools (**photo 10**). Finally, Alex du Pré's 'leftovers' (**photo 11**) seems to be an appropriate image to finish this roundup.

Thanks to everyone who entered the competition, I hope to feature some of the images as cover shots in future, and if space allows I may also feature a few more entries in a future issue. I hope you've enjoyed seeing these pictures as much as I have.

Neil Wyatt.





The M2Z Widget

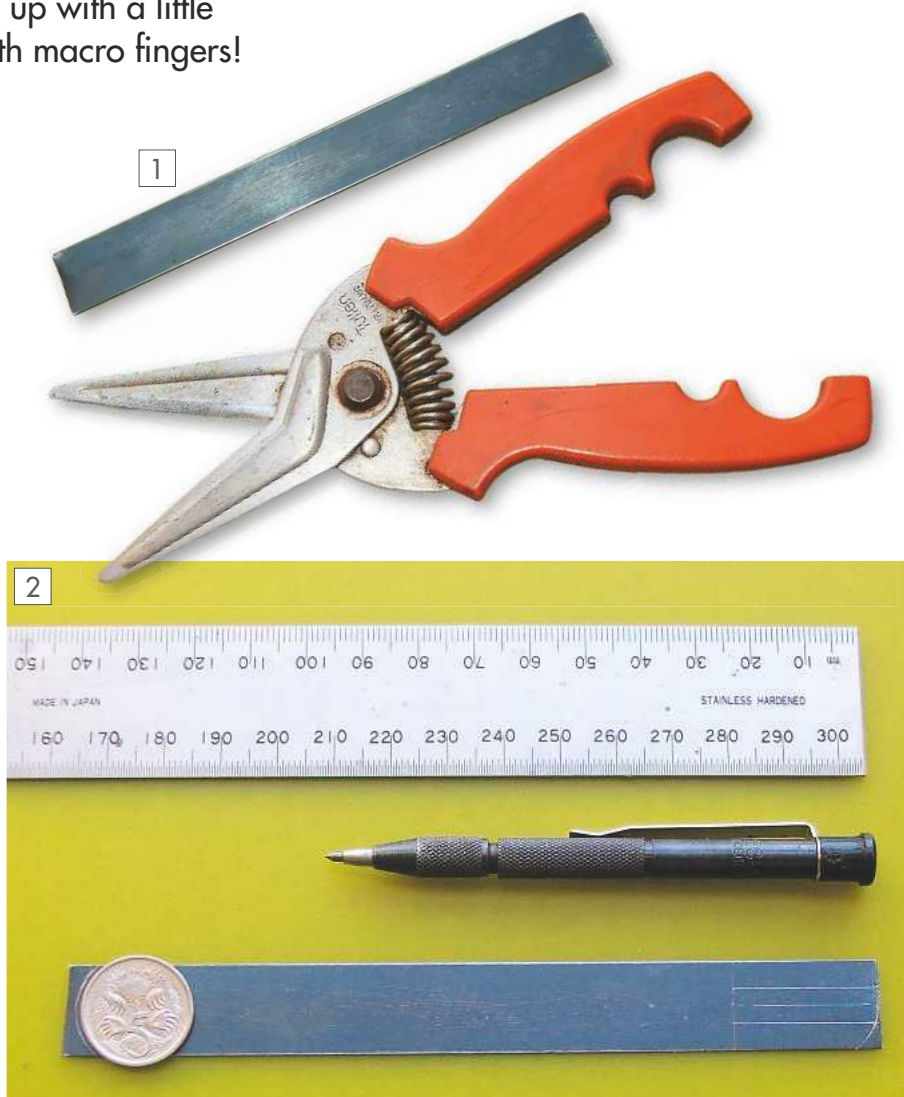
Danny M2Z* in Australia comes up with a little gadget for mini-lathe owners with macro fingers!

The mini-lathe is a popular workshop machine. They come in many colours and different sizes, but they all seem to share one annoying problem: Fitting the nuts behind the chuck or faceplate is tricky as there is not a lot of room and fat fingers aggravate the problem of getting the nuts started on the end of the studs. Also, when removing the nuts it is easy to loose them if they fall (they always seem to hide behind or under something). Many mini-lathe users complain about this.

To overcome this problem I invented this widget. A widget is a device that does something useful, but has no real name. If it's cheap and simple even better. My widget costs virtually nothing and has just one non-moving part, so I think that it qualifies. It took longer to write about and photograph than to make it.

Materials are simple; a piece of pre-loved metal strapping about 150mm long (photo 1). The tools you need are metal snips or tough scissors, a scribe, a ruler, a pair of pliers and a file.

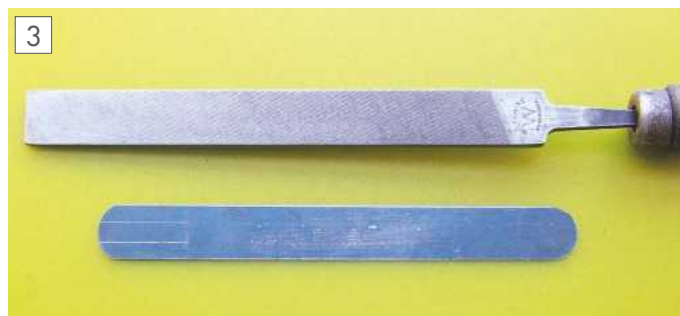
Lightly mark the centre of one end and scribe a pair of parallel lines 25mm long, one each side of the centre mark and 6mm apart (photo 2). Measure the width of the strapping (mine was 16mm) and round the ends by filing (photo 3).

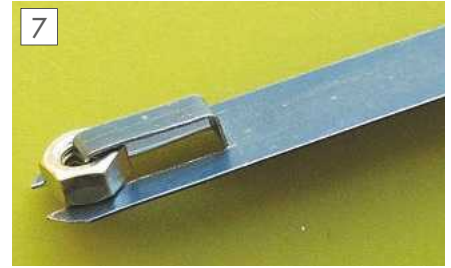
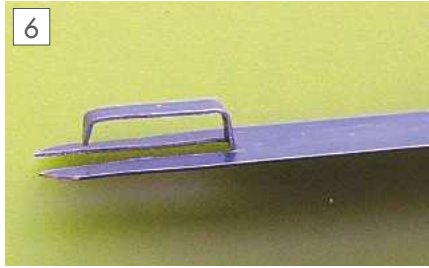
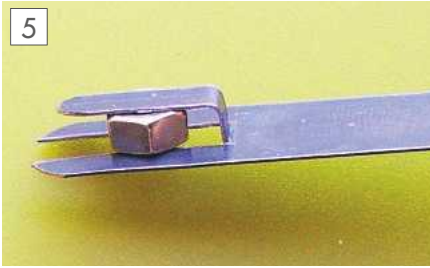


A widget is a device that does something useful, but has no real name. If it's cheap and simple even better.

Using the snips or scissors (I used tough kitchen scissors) cut along each of the lines. Use the snips and file to shape the end of the middle finger to a rounded tip (photo 4).

Use the pliers to bend down the tip of the middle finger about 3mm, bend the other end of the middle finger vertical where it joins the rest of the strip (photo 5), then bend it forward about 5.5mm





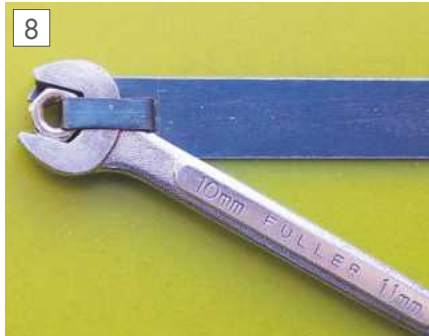
above the previous bend. Straighten the outside fingers and the result should look like this (**photo 6**). (I also rounded the other end of mine and drilled a hole to hang it on a peg, this is optional).

A mini-lathe chuck nut is usually M6 thread, 10mm across the flats and 5mm deep. It fits into the widget as in **photo 7**.

A 10mm open ended spanner has room to swing more than 240° in the slot (**photos 8 & 9**).

To use the widget, insert a nut and hold it against the end of the stud of the mini-lathe while using an open-ended spanner to tighten the nut (**photo 10**). As the stud moves through the nut it will push the tongue of the widget away from the nut until it can be slipped off.

When removing a nut, when it is nearly off, use the widget to grip the nut so that it does not fall and hide in your workshop (**photo 11**).



**My Polish surname starts with M and ends in Z and as it is not easy to pronounce in English, my Aussie Army mates christened me Danny M2Z.*

MODEL ENGINEER

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Dead Blow Hammers



Ted Jolliffe tells us about a tool that has been immeasurably useful through the years and gives some directions for easy home manufacture. It is aimed at the newcomer to our hobby, hence the detailed description.

Way back in the late 1960s I acquired a small boat fitted with a single cylinder Stuart Turner petrol engine. The whole thing needed lots of TLC on the hull. As for the engine it took a time to bring it from a rusty heap to a reliable working unit. I was, as ever, short on cash and high on enthusiasm, so resolved to overhaul the engine myself.

All went well until I came to the crankshaft, which was built up of two machined discs of cast iron, with the big end and crank pin passing through tapers and secured by nuts. After a lot of struggling I got them apart but having replaced the bearing, getting the crankshaft lined up accurately defeated all my efforts.

In desperation I phoned Stuart Turner, and was advised by a friendly voice to come on down and they would show me how it was done. At that time I was on shift work so my next weekday off was scheduled for the visit. (This was well pre-Internet and I could not find a lot about the engine in the library).

On arrival I was taken to a bench where an elderly man was seated. He had a pair of centres mounted on a plate with a set of DTI's on hinged brackets set so they would come into contact with the discs. Other equipment included a long tubular bar, a selection of socket spanners and a lead hammer.

He first tried my efforts at tightening the nuts securing the crank pin and, grunted his satisfaction. He then set the whole assembly up on the centres. Swinging the DTIs into position he revolved the shaft, and watched the DTI needles. Stopping the shaft, he swung the DTIs out of the way and gave one disc a strong biff with the lead hammer. It took three or four more tests and clumps before he was satisfied that all was running truly. He then flogged the retaining nuts up even tighter.

As it was lunchtime I accompanied him to the nearby pub, bought our lunch and chatted about the working methods.

He explained that when a crankshaft was tightened by the crankpin nuts, the only way to achieve a tiny movement to correct the run-out was by a blow from a 'dead blow' hammer, as there was no tendency to 'bounce'. The lead one answered perfectly. It jarred the components better than any normal hammer or combination mallet.

The lead hammers were made in the works. Each Friday afternoon the last job was to insert the hammer in the mould and melt the lead back to original shape. Theirs were egg-shaped, as that was the mould they used. It seems that it was only



once every few weeks that any additional lead was added, very little was lost. As I recall they were much like the lead forming hammers used at that time by GPO linesmen when forming lead sleeve over a bundle of wires in the manholes in the street).

I determined to make such a tool for myself, and that winter did just that and have used the tool in the workshop for many years, to tap down a job onto parallels in the vice, or occasionally to persuade a reluctant nut to come undone, especially while my son and I were building his kit car in the 1990's. That first one was cast in an empty can which had contained baked beans and was really far too heavy for my purpose. One gets used to everything in time and I am still using it. It also came in useful for odd panel beating job on the youngsters' cars.

Several friends who have visited the shop expressed interest so I thought I would make one and record the details.

Biggest problem for a one-off constructor is obtaining a suitable mould to form the head.

The supermarket to the rescue

During a shopping trip I spent time looking for the smallest round, canned food available.



A choice of tins, the empty one held Heinz toasty topping, the others are still full. All are similar diameter, just the height on the pilchard one differs.

Balanced on a piece of wood - don't forget the saw cut to accommodate the lip left by the ring pull. Note the tiny chisel, made from a scrap Allen key.

I suggest that the tin containing the popular small Glenryck Pilchards, which is similar diameter but a bit taller than Morrison's own brand tomato puree. Both are readily available and suitable (**photo 1**).

I emptied the tin, removed the paper wrapper and ran the empty tin through the dishwasher. I found the inside was painted white. The puree tin had the surface painted, so it could well be left, after all the tin is sacrificial in this context. The tin I actually used had contained Heinz Toast Topper, but I am informed that this has now been discontinued.

A well-defined line showed where the joint came in the cylindrical part of the tin. This makes a useful marker later on, and my method was to pierce a hole midway between base and top opposite that line, which makes it easier to line things up by eye later.

Unfortunately the top of the tin is often nowadays a ring pull, so there is a ridge of metal left once the lid is removed. If the tin is so fitted, proceed as follows, if not forget the saw cut.

The side is quite flexible, so in order to support it while piercing the hole I cut a small groove into the narrow part of an off cut of 2 x 1 in. wood, using a well worn junior hacksaw blade, leaving enough to mount the inboard end in the vice (**photo 2**). Then by balancing the tin with the lid



The screws in place through the handle, a little room left so that the handle will finish up enclosed.



The set-up ready for pouring, note the seal formed around the handle to prevent spillages.



The pour in progress, the old tin lid is to catch any spills.



The filled mould tin. Watch out for spills and top up with fresh molten lead as the contents of the tin shrink due to bubbling and cooling. Shown here in the old biscuit tin lid which acts as a drip tray, apologies for the bench, it is the dirty workshop.

flange resting in the groove of the wood I was able, using dividers, to scribe a circle the diameter of my chosen handle; following up with a small chisel (made from a redundant Allen key) and chopping out the hole for the handle. The wood allowed a slight spring in the side of the tin, which sprang back when the pressure was removed.

For the handle I used a short (9 inch) length of $\frac{7}{8}$ inch steel tubing, actually a bit of water barrel, I have used part of a leg from a scrap stacking chair on others..

There is a small precaution here, if you cast the lead around the bare tubing, it will, in time, work loose, and no-one wants to risk a large lump of lead flying around as a hammer blow is delivered.

The solution is simple; a couple of cross-holes are drilled at right angles so that they will fall within the cylinder of the mould. I inserted a couple of $1\frac{1}{2}$ in. woodscrews, the current cross head quick thread variety. They do need to be fairly secure in their holes; otherwise there is a risk that they will float on the dense molten lead when the pour is made. Drive a plug of dry wood into the end of the tube, it acts as a seal for the lead later. Run through with a smaller drill to give the thread something to grip, then open up the further hole to clearance size.

Pop them in first with the handle held in the bench vice, make sure they are a good fit but screw easily. The other point at this

time is to bung up the end of the tube on the outer end, just in case. Molten lead is extremely fluid and will find its way through quite small holes. Another plug carved from a piece of wood and hammered in serves well. Do take the precaution of having all as dry as possible, otherwise any entrapped water will flash into steam when the lead is poured. I haven't seen it done, but can imagine that there would be interesting consequences.

Photograph 3 shows the screws in place when almost ready to pour the lead.

Keep it level and safe

Now with all ready, the final preparation job is to make up a wooden stand to hold the handle at right angles to the tin while the hammer is completed. Another bit of the 2 x 1 in. timber was used, with a suitable hole for the handle drilled through the wide side close to centre height. This was screwed onto the base timber and then slid over the outboard end of the handle (**photo 4**). The screws were inserted to form two crosses at roughly 90 degrees apart, screwed in with about half of each on either side of the handle. As the lead cools it will shrink appreciably and grip handle and screws tightly.

Final preparatory job is to ensure there is an adequate seal where the handle enters the side of the tin. I used a lump of Blu-tak

rolled between my hands into a rough cylinder, and then wrapped around the handle and pressed up to the tin to form a flexible seal.

For work of this nature I keep the top of an old biscuit tin by the brazing hearth, the job is stood in this so it forms a tray to catch any spilt lead, should there be a leak, or overflow. Better to take this small precaution than having hot lead on your feet or trousers.

The melt and pour

Using similar materials to mine you will need to melt sufficient lead. to fill the tin in one melt. I use an old milk saucepan, relegated from the kitchen as my crucible. I have a Calor gas ring, and used this as my heat source. There can be quite a smell and a lot of acrid smoke when melting lead, caused by detritus, oxide film, char and old paint, etc. burning off. It could be done on the domestic cooker, quite easily, I have no suggestion how to make the peace should you go about the job in that fashion!!

Remember that molten lead, although not terribly hot compared to some of the things we do (about 327deg. C) can still give a nasty burn, and take precautions to obviate any risk. Ensure that the mould is dry; quite a tiny amount of water suddenly flashing into steam under molten lead will cause an interesting eruption.

Once the metal is molten a brownish scum will form on the surface, I use an old dessert spoon mounted brazed onto a bit of steel rod as a ladle to gather as much as possible of this from the surface immediately before the pour.

When pouring do so steadily, and make sure that you fill the tin to the top, and have a drop left to top up as the level shrinks as it cools (**photo 5**). There will be a lot of bubbling as air in the tube is forced out, the level drops quite a lot so top up as required - keep the molten lead in the saucepan simmering it cools quite quickly.

Once the pour is complete leave the lot to cool naturally for an hour or so, a lump this size will take at least that long (**photo 6**). Do not be tempted to hurry things; you could well form air bubble on the metal.

Sacrifice the tin

When all is cool, remove the remnants of the Blu-tack from the handle. Grip the handle in the vice and using a small chisel (purists skip this bit) an old wood chisel will serve or a thin cold chisel. Once the ribbed top of the tin is removed it is little

effort to twist the thin metal around a pair of pliers to remove it. A few taps with the hammer will break through the lip of metal where the ring pull was. Now grab one side of the broken tin in a pair of pliers, and using them like a sardine can key twist the tin so that it rolls off the side of the lead, try to organise it so that the final break comes at the handle (**photo 7**).

You may have to lever out a fresh section, to grip should you be unlucky and break the tin.

Once you are near the bottom a light tap with a normal hammer will remove the base of the tin, and you have ready to use lead hammer (**photo 8**).

Don't worry that there are a few small dints in the surface, they are surface bubbles caused by the paint melting. The first couple of jobs you try will remove them.

You may find a small quantity of lead has got past the screws and run down inside the handle. Don't worry, it will just add to the power of the tool.

Remember you will largely tap with this tool, a heavy blow could ruin a small part but as an old friend described his hammers, a gentle tap with a goading iron is often all that is needed.

If anyone knows of a readily available tin to form the mould, which comes out, smaller than mine please let the rest of us know about it.

A final caution

Years ago I made a mould from Plaster of Paris (aka Polyfilla) in a cigarette tin to allow me to cast my own sea fishing weights (). The first attempt ended in disaster; there was too much water in the plaster and I got a spectacular bang as the mould flew everywhere. I won in the end but found I had to bake the mould in the oven for an hour or so to dry it out before casting. We worked out that it was cheaper to buy the weights from a tackle shop - and as my wife remarked less nerve wracking. Be warned and do not be tempted to try making lead hammers in the same fashion, plaster is not good mixed with molten lead. For interest I show a picture of that first mould and a later cast aluminium version which was very useful, until they banned lead for fishing weights. It had to be blacked with a candle flame before each use - the soot acted as release agent (**photo 10**). ■



Unwind the scrap tin using a pair of pliers.



The new tool, the only cleaning up was a rub with a wire brush to get rid of the powdered paint that caused all the bubbles.



This is the Plaster of Paris mould I made years ago - somewhat battered after the passage of time. Shown with a commercial mould in two parts made in cast aluminium.



They get a bit battered over the years, this is my old lead hammer still in frequent use. The sacrificial tin used here was a small baked beans can - really too heavy to be comfortable. But if needed it will deliver a mighty wallop!

Readers' Tips



This month's winning tip is from Mike Matthews, who wins £30 of Chester gift vouchers for his convenient electrics tip.

TIP OF THE MONTH WINNER!

Socket Suspension

Here are some photos of a small adaption I made when recently refurbishing my workshop. The first thing I did was to put a couple of 'Metalclad' sockets outlet on the end of a suspension chain supported from the roof beams mounting them on a piece of flat bar.

This I found to be very useful for using portable tools on the bench. If the sockets are in the way for other tasks they can be hooked up from the beam out of the way. Naturally, make sure the metal parts are earthed and that grommets and cable tension relief are correctly fitted.

The second associated item was a small halogen floodlight that I originally mounted on a piece of MDF just to make a useful task light. I then discovered that by the addition of a couple of screw eyes and some hooks on the roof beam (make sure each hook is the opposite way round so it won't work loose). I then had a very useful portable task light over my bench.



It may be very obvious but I have found it to be a flexible and very easily installed way of providing task lighting. I hope you find this interesting.

Mike Matthews

We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'.

Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. **Don't forget to include your address!** Every month we will choose a selection for publication and the one chosen as **Tip of the Month** will win £30 in gift vouchers from Chester Machine Tools. Visit www.chestershobbystore.com to plan how to spend yours!

This month's runner up is William Skinner, who suggests that adapting a vice for delicate work is a good idea. He wins an Edge Technology lathe tool setting gauge.

Gentler Jaws

If you are doing finely finished work, and I would be rather surprised if you were not, then it is essential to protect the finish of the component at every stage, especially the last one. Again if you do any work by hand it is likely that you will use a bench vice. For all work except the very roughest I recommend that you replace the vice jaws with mild steel of a similar size. Just obtain some bright rolled steel (BMS) the same size, cut to length, drill and countersink (make sure the screws sit slightly below the clamping face) and fit to the vice.

You will find that the vice will still grip strongly enough for all hand work but will not mark the work. If you are doing fine finishing work on steel then procure another vice, perhaps a little smaller than the one used for general work, and replace the jaws with brass. If you are doing fine work on brass then just be very careful, or perhaps you could try lining the jaws with masking tape, or gaffer tape. When I was an apprentice back in the 60s all the fitters' vices had their jaws replaced with mild steel.

You can get fibre soft jaws but as they are removable, one will inevitably get lost, also they are often held in place by rare earth magnets which are (very) strongly attracted to steel filings and will never let them go.

William Skinner



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Polly Put the Kettle On



The Editor pays a visit to a busy workshop to discover the secret behind the success of the Polly locomotives.



Neil Mortimer driving his Polly III on the Nottingham track (with mum and dad behind) as Polly V goes by on the adjacent track

You would think that one of the greatest benefits of being editor of Model Engineers' Workshop is the excuse to be constantly visiting all sorts of wonderful workshops - If only! But once in a while, they do let me off the editorial leash and I get to go somewhere interesting, and recently enjoyed a visit to Polly Model Engineering in in Long Eaton, Nottingham. Polly are renowned for their popular range of five-inch gauge Polly locomotives (**photo 1**). The original series of four locos, I – IV were designed by J.G.S. Clarke in the 80s, and the current company was established sixteen years ago by Andy Clarke. Since then *Pollies* V and VI and Orenstein & Koppel 0-4-0T *Caroline* and 0-6-0T *Suzanne* have joined the range, together with an 0-4-0 tank *Trojan* (**photos 2 & 3**) and the latest, loco a 2-6-2 tank of decidedly GWR appearance (**photo 4**), which goes by the name of its wheel arrangement 'Prairie' or 'Polly X'. These two latest locos together with Polly V and 6 are something of a departure, as they are 'mainline' locos, rather than the narrow-gauge styles of the original JGS Clarke *Pollies* and O&K locos, although much of the tried and tested running gear is in common with the Polly design.

Now in what has been a rather troubled area of the model engineering hobby over



The somewhat dusty, but purposeful prototype Trojan.



The backhead of Trojan is very neat.



The new prairie tank engine.



Apprentice Mat's skills go way beyond drilling holes!



Some of the huge stock of parts for the Polly range.



Brake standards, all interchangeable.



The Ward capstan lathe. The central toolholding capstan indexes around performing different operations as it is moved back and forth with the huge handle in the foreground.



The paintwork is showing its age, but still with silky-smooth slides this Colchester Student is a real workhorse.



This CNC Colchester lathe is a bit of a contrast to the Student!



The indexed workhead of the CNC Colchester.



Shelves of pre-loaded cutters speed up job changing and help avoid errors.

the years, the 'Polly' range of locomotives stand out with a reputation for reliability and owner loyalty (as the popularity of the Polly Owners Group and regular Polly rallies testify). The history of kit model locomotives, (or at least some of the other manufacturers) is not an entirely happy one, with some builders struggling for years to get their locos to run successfully, or being left in the lurch when the manufacturers folded. On my visit I was keen to find out how Polly had achieved such success in a challenging area.

Andy Clarke is a former toolmaker and also a model engineer – he didn't say so, but the pride he takes in getting things right must be a big part of that success, but so is his team. His wife Jayne and partner 'Professor Pete' Thomas (yes a real one – he's emeritus professor of Industrial Computing at Nottingham Trent University) run the business, ably assisted by a team of enthusiastic and able engineers – most of whom appear to be called 'Mat'.

While Andy keeps busy in the workshop, Jayne looks after the office and the busy model engineers' supplies business which visitors to the shows will be familiar with as the face of Polly. Pete hides in the background, involved primarily with design work and administration.

The team includes a very able and enthusiastic apprentice (Mat) who is clearly getting the right sort of hands-on experience (photo 5) rather than just making tea and sweeping up (although he does make excellent tea, hence the article title). It's great to see skills being passed on in this way. A further member of the team (also called Mat!) organises the collation & packing of

All in all, my visit was something of an eye-opener. Whilst it wasn't a surprise to see CNC machine being used to produce parts, I was surprised to see that these were all sizeable machines, as might be expected in many specialist engineering shops.

the loco kit parts when not busy making tanks or helping Jayne. In a small business like Polly, staff have to be versatile and the team spirit within Polly is clear to see. Perhaps the biggest 'secret' behind the success of Polly Models, over and above the original sound engineering of John Clarke's original designs, is repeatability. If you have an early Polly I and need a spare 'thunkling valve', they can send you one off the shelf (photos 6 & 7), and you can be confident that it will fit – no different to buying car parts. Naturally, if parts can be made to such a standard, then kit-builders can have a high level of confidence that the parts they receive will all go together to make a loco – and one that will work!

In the early days this Ward capstan lathe (photo 8) must have been a mainstay of production. Fitted with a roller die box, it clearly doesn't stand idle all the time, and a nearby Colchester Student (photo 9) still gets regular use. Although the capacities of these machines are not huge by workshop standards, their massive, solid construction makes using them a

very different experience from smaller benchtop machines.

Polly's real secret, has been investing in a number of big CNC machines (photo 10), allowing the production of repeat parts to high levels of accuracy, and of course the big advantage with CNC is that you only need to get the part right once, then every subsequent one is the same. Andy also says that a second major advantage was not having to work 80-hour weeks at a lathe to keep up with demand!

I'm afraid that due to the copious amount of coolant behind the window, I couldn't quite figure out what this Colchester machine in photo 10 was doing, but Andy demonstrated how it was literally the work of a few minutes to programme it for a simple part. Inside the indexing toolhead (photo 11) includes an ER32 collet holder – I have never seen so many of these before (photo 12). Polly use them almost universally for holding mills and drills on the CNC machines and keeping dozens of cutters sharp and preloaded helps keep things moving.



13

The Star VNC-20 automatic lathe with its big bar feeder.



14

The business end of the Swiss-made Star VNC-20.



15

This weighty pair of Jones and Shipman vices have a dedicated chain fitted to help with moving them around.



16

Inside one of the Bridgeport machining centres.



17

Koppel cylinder covers, fresh from the CNC mill.



18

Despite the new machines, there is still room for a manual Bridgeport.



19

Every workshop needs a copy!



20

Loco cab kits lined up for despatch.



21

A beautifully made 'Koppel' boiler.



One of the fine Practical Scale patterns.



Two hefty cylinder castings.



These driving wheels show crisp spoke detail.



A large stock of welded spearpoint superheater tubes.



The CNC routing machining producing brass sheet parts.



A closer view of the CNC workhead in action.

Another nearby machine was a massive Star VNC-20 Swiss automatic lathe with a bar feeder for 3m stock (**photos 13 & 14**). From tiny brass fittings to big steel parts, this machine can happily chunter away producing bins of parts.

Not all of the machining can be done on lathes, of course, a couple of van-sized Bridgeport machining centres (**photos 15 & 16**) can produce complex cylinder covers from solid without the need to work from castings (**photo 17**). Despite the presence of the big machines, a very nice manual Bridgeport sat, rather forlorn, under the stairs (**photo 18**). Indeed not everything is CNC, the workshop still has many manual machines, especially presses, drills and the like, and I couldn't miss a very well-thumbed copy of Tubal Cain's *Model Engineers' Handbook* – Andy says he would be without it (**photo 19**).

After looking around the machines, I took a look in the two upstairs areas where all the finished components, castings and drawings are kept. Light and airy with big northlights this could be an ideal drawing office for a dozen draughtsmen, but now is lined with shelving and racking and a long bench for batching up kits and the like (**photo 20**).

In 2014 Polly announced a collaboration agreement with Ken Swan, allowing them to distribute castings and drawings for his popular locomotive models. Prominent in the Polly workshop was a magnificent Koppel boiler (**photo 21**) showing some of the neatest silver-brazing I have ever seen.

Polly are also supply a range of castings and prepared parts for a range of fine scale loco models. Development of this range started with collaboration with Neville Evans' in producing Penrhos Grange under the *Practical Scale* banner. The range now includes designs by Peter Rich, David Aitken, John Smith and Nick Feast. Pete makes now apology for the GWR bias in the model range which

reflects his background and interest. Some of the patterns (**photo 22**) are works of art in themselves, where Pete has produced 3D models on computer and machined patterns on the Pacer routing machine which he developed in a former life. The resulting castings (**photos 23 & 24**) are excellent. Polly also distribute the former Bruce Engineering range of stationary engines, including many of Anthony Mount's designs, again with excellent casting quality. Also in this Aladdin's Cave were many boxes of interesting bits – some easily recognised (**photo 25**) and others not at all of obvious purpose. Polly can in fact supply parts for many GWR locos beyond their listed range.

Some of the sheet metal parts used in the various models are laser cut, but others are produced in-house using a CNC machine. This is one at the small end of those designed by Pete in his earlier career. Back downstairs, his son, Mat, was operating one of these machines (**photos 26 & 27**), which appeared to be turning out side tanks for the new loco. Upstairs I

had seen a number of part complete tender tanks with vast numbers of precisely drilled small rivet holes, assembled from parts made on this machine (**photo 28**).

All in all, my visit was something of an eye-opener. Whilst it wasn't a surprise to see CNC machine being used to produce parts, I was surprised to see that these were all sizeable machines, as might be expected in many specialist engineering shops. The quality of the parts being produced, from tiny brass fittings you could pick up by the handful to weighty cast iron items was obvious. For example, Andy handed me two random parts to fit together – a cylinder and a cover – the sort of parts we normally machine to fit each other and mark as handed pairs. They were a perfect push-fit, and all the holes lined up too.

But not only was it interesting to see the machines in action, it was also good to meet a team of people who so obviously enjoy and take pride in what their workshop is producing. ■



A pair of incomplete tenders made up from brass sheet parts.

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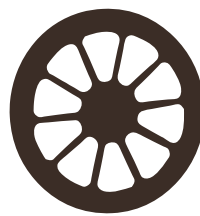
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One Man and his Lathe

Darren Conway and his Denford Viceroy Lathe



In a slightly longer than usual episode of this popular series, Darren Conway tells the story of his Denford Viceroy TDS1/1.GB.

Ever since I was a teenager at college, I wanted my own lathe. I took shop work engineering as a subject at school where I made a simple oscillating steam engine that earned me the top grade in the class. When the school Boxford lathes came up for sale, I wanted to buy one. They were completely worn out and thoroughly abused but they were the only lathes I had ever seen. Fortunately I didn't have the money to pay for one or the space in my workshop. My workshop was primitive by any standard. It was a tiny garden shed. On one side was a large chest freezer and on the other, a crude bench. My selection of tools was sparse. The only power tool I had was my Father's electric drill. I didn't even have a vice. As much as I wanted a lathe, it simply wasn't practical. Given their poor condition a purchase of one of the school lathes would have ended in disappointment. My desire to own my own lathe remained unfulfilled.



The Denford Viceroy lathe.

When I left school I joined the Royal New Zealand Navy where I didn't have the time or the space for a workshop. What I did have was access to the workshops of the Naval Dockyard. The dockyard workshops contained every type of tool imaginable. Lathes ranged in size from 12 foot swing in the heavy machine shop to tiny jewelers lathes used by the watch maker. There were gear cutting machines, CNC lathes, planing machines and milling machines of all sizes. It was undoubtedly one of the best equipped facilities in the country. For a few summers I was lucky enough to work in the Dockyard as part of my training where I

was able to use some of the machines. The making of 'homers' was an accepted part of the culture at that time. Opportunities do to that were limited so I got to see a lot of machine tools I was never able to use. I still didn't have any sort of decent workshop at home. Even if I had, most of my time was taken up with work, raising a family and house renovations.

Roll forward another 20 years when I had largely finished renovating the fourth house, my two offspring were now adults at university and I was finally able to indulge myself and look to buying a lathe. The next step was to go to the market and start a search for a suitable machine.

Politics, Economics and Machine Tools

The political and economic history of New Zealand has had a profound effect on the current new and used machine tool market. Up until the mid-1980s, the New Zealand Government maintained extraordinarily tight control on the import of goods and access to the foreign currency needed to buy them. There were numerous hurdles put in place to make the purchase of foreign goods difficult and expensive. As a private individual it was necessary to buy foreign currency in strictly limited amounts over an extended period to build up enough to make a purchase.

An import licensing system severely constricted the flow of imported goods. The import license system was biased towards long standing trading companies and against individuals. This gave those trading companies a virtual monopoly on the supply of goods they held licenses for. They were able to apply high markups which customers had no choice but to pay. Many goods were subject to customs duties that served as revenue and to protect local industry. By the time a customer had paid shipping, duties and monopoly markups, any imported goods were extremely expensive.

Although industrial machine tools were mostly exempt from Government import licensing restrictions, the combination of remaining barriers made importing machine tools difficult and very expensive. An engineering company could only justify the time and cost if they had high utilization. The machine tools had to be worked hard to get a return on investment. As a direct result, any industrial machines imported prior to the 1980's are now usually at or beyond the end of their useful life.

The controls applied to Government imports of machine tools were more relaxed. The Government was the biggest single importer of machine tools for state industries, teaching institutes and Government workshops. The most common school lathe was the Boxford. Usually these were the basic models with few accessories like the ones I used at school. Even in my teenage years, these machines had suffered much and were usually missing accessories that would be too expensive to replace.

The most common model-makers' lathe imported at the time were Myfords. These

were compact and easy to ship. Importing a lathe was so expensive and so difficult for an individual, it made sense to include with the order a generous selection of accessories. Ordering these separately at some later time was again both difficult and hideously expensive. After a model engineer completed the process of buying and importing a lathe, so much time and money had been expended, the lathe was almost too valuable to use. It is not uncommon even now to find Myford lathes in near factory new condition with a comprehensive set of genuine Myford accessories. These still come up for sale on the local on-line auction site.

The current supply of used machine tools is a result of past Government policies. Small industrial grade machines are usually flogged-out except for a handful from University workshops. Machines used in training establishments are often basic and heavily abused. Many hobbyist machines are low grade Asian or small and British.

Things have changed

Since the 80s, both import and currency restrictions have been largely eliminated. Foreign currency is readily available in any quantity. The Internet makes it possible to find and do business directly with suppliers anywhere in the world. Imported machine tools now attract only 15% sales tax. The influx of cheap Chinese lathes has greatly increased competition and pushed down the price of new and used lathes compared to the pre-80s. All of these changes make it easier than ever before to find a lathe.

The Search

In the late 90s the planets of finance, circumstance and opportunity had finally aligned and I was able to begin my search for a lathe. After reviewing the options. I quickly determined that the new imported Asian lathes were of dubious quality with limited life expectancy. New high quality lathes were way beyond any budget I could justify. I decided to aim for a well-made used lathe. I reasoned that a good quality old lathe was a better proposition than a new low quality machine.

I was looking for a lathe large enough to bore the cylinder and head of a Yamaha

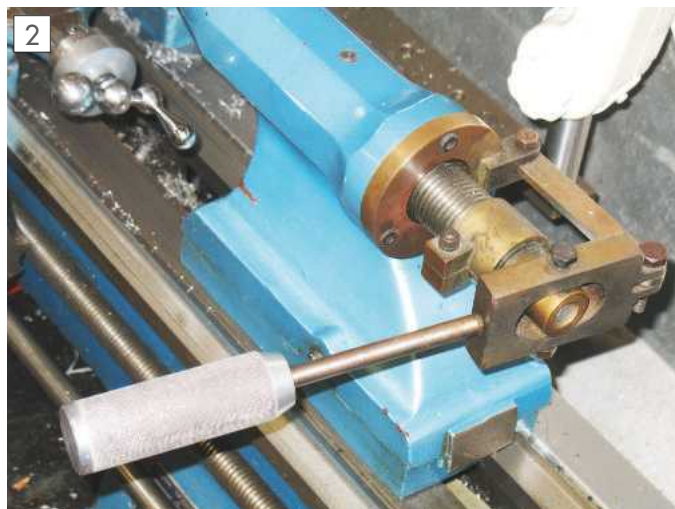
KT100 kart racing engine. That required at least a 5 inch swing and ruled out a Myford. It needed to run from a single phase power supply because installing 3 phase power in a residential area costs way too much. I wanted a well-made lathe in very good condition. I wanted something with a good range of accessories and features because they are too expensive to purchase or retrofit separately. All of these requirements severely narrowed the choice of machine.

With these requirements in mind, I started my search. At that time, on-line auctions were a relatively new but popular trading phenomena. The local auction site gave me visibility of sellers in a way that was never before possible. New Zealand is about the same size as the United Kingdom but with a population of only 4.5 million. As such, the market for machine tools is small. The historic effect of import restrictions further limited the pool of pre-owned machine tools. It took me nearly three years of searching to find a lathe that met my requirements. When I first saw it on the on-line auction site, I had never heard of Denford lathes but research on the www.lathes.co.uk website convinced me that this was a good candidate. It was a quality lathe in the right size and appeared to be in the right condition.

Without first seeing the lathe in person, I placed the winning bid and then organised collection. The lathe was in a remote location at the other end of the island. The cost of having it collected and delivered by a transport carrier was eye watering. It carried the added risk of damage in transit. I rented a trailer and drove by myself two days north to collect the lathe, then two days to get back. It was worth the trip. I cursory inspection at collection indicated that I had purchased a very good lathe with a comprehensive range of factory accessories.

The Denford Viceroy T.D.S.1 / 1G.B

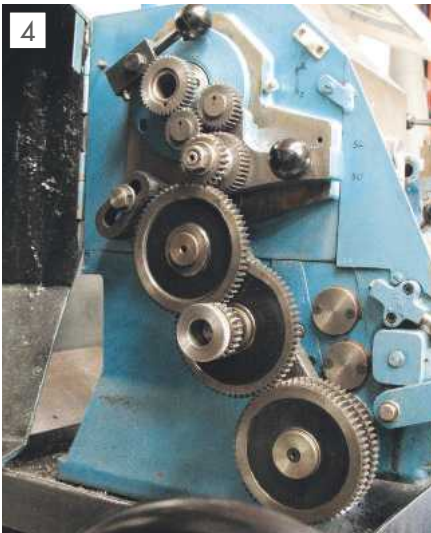
The Denford is essentially a superior version of the Boxford. It has a heavier bed and includes some features not found on the Boxfords. It was designed and made by Horace Denford, the founding owner of Boxford. The key features of my lathe that differentiate it from a typical Boxford are:



The lever action tailstock.



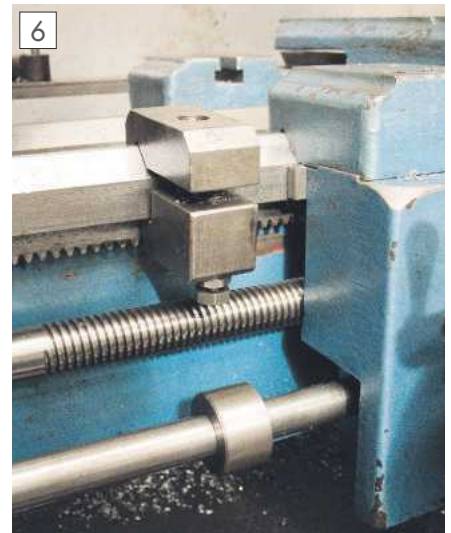
Viceroy threading chart.



The back gears include a tumbler set for forward and reverse feed.



Spindle lock to aid the removal of chucks.



The stop on the feed shaft disengages it, and the best stop will open the half-nuts.

The Denford wasn't used for factory maintenance, it was used to make model steam engines. The lathe remained with the original owner until he passed away.

- Hard chrome bed
- Separate feed shaft and lead screw
- Spindle speeds from 60 to 1350 rpm
- Power cross feed
- Adjustable knock-off on the half nuts (useful when threading to a shoulder)
- Two and four way tool posts
- Taper/copier attachment,
- Coolant pump
- MT 3 tail stock and head stock spindle

My Denford Viceroy lathe as it is today is shown in **photo 1**. It has been rebuilt, and various modifications made. The splash-back, shelf and magnifying light have been added. I have also fitted adjustable feet to raise the height and seismic restraints to hold it steady in earth quakes. My lathe was fitted by the original owner with a shop-made lever drive on the tail stock quill that replaces the usual hand wheel drive shown in **photo 2**. This has proven to be a very useful accessory that would enhance any lathe.

A nice feature is that the entire thread cutting range of 48 threads (**photo 3**) is available without the need to change the back gears. There is the option to fit different back gears (**photo 4**) but the imperial version of the Viceroy lathe doesn't come with spare gears and I have never had a need for imperial threads outside of the range of the gearbox.

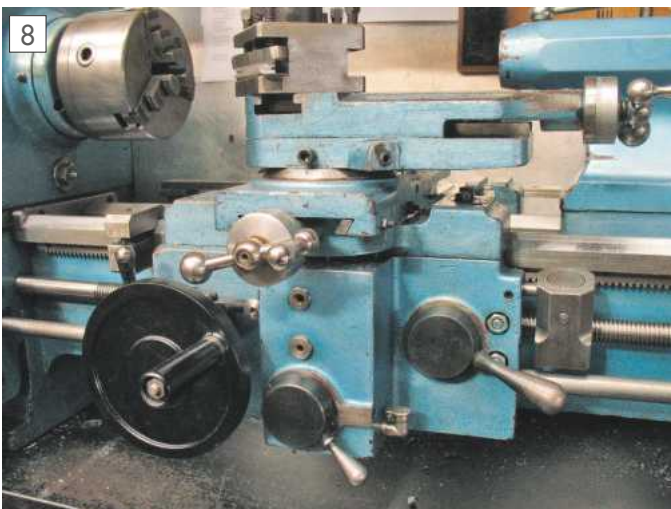
The most obvious disadvantage with my Denford is that it doesn't cut metric threads. Like most of the world, New Zealand is a metric country and not being able to cut metric threads is a significant limitation. On the other hand, the ability to cut imperial threads has turned out to be essential feature for making tools for the lathe. The lathe itself has all imperial threads including the spindle nose. Ideally, I would like to be able to cut both imperial and metric threads. I have looked at various options to enable metric thread cutting but none were satisfactory. So far I have been able to get



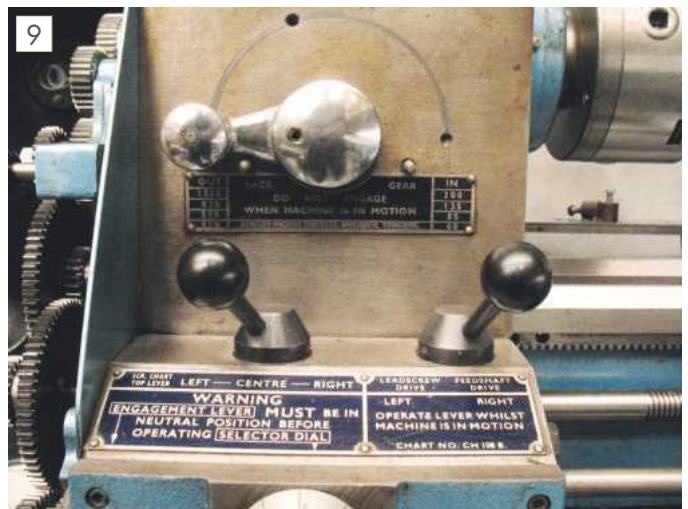
A steel version of the original rubber kick-switch.

around the need to make metric threads but it is still a significant deficiency in a metric country.

The Viceroy is fitted with a number of safety features. The doors are fitted with micro-switch interlocks. There is a shear pin within the back gears to protect the gearbox against overload. The spindle lock shown in **photo 5** can only be engaged with the cover opened, which disconnects power. A hidden dog clutch disengages the feed shaft if the apron pushes against the adjustable stop (**photo 6**). The original kick-stop was pneumatic with a limited life. I have fitted a steel kicker as shown in **photo 7**. The apron and headstock controls seen in **photos 8** and **9** are robust and easy to operate.



Simple apron controls.



Clear instructions make it easy to operate the gearbox.



The apron being stripped down and cleaned.

The Rebuild

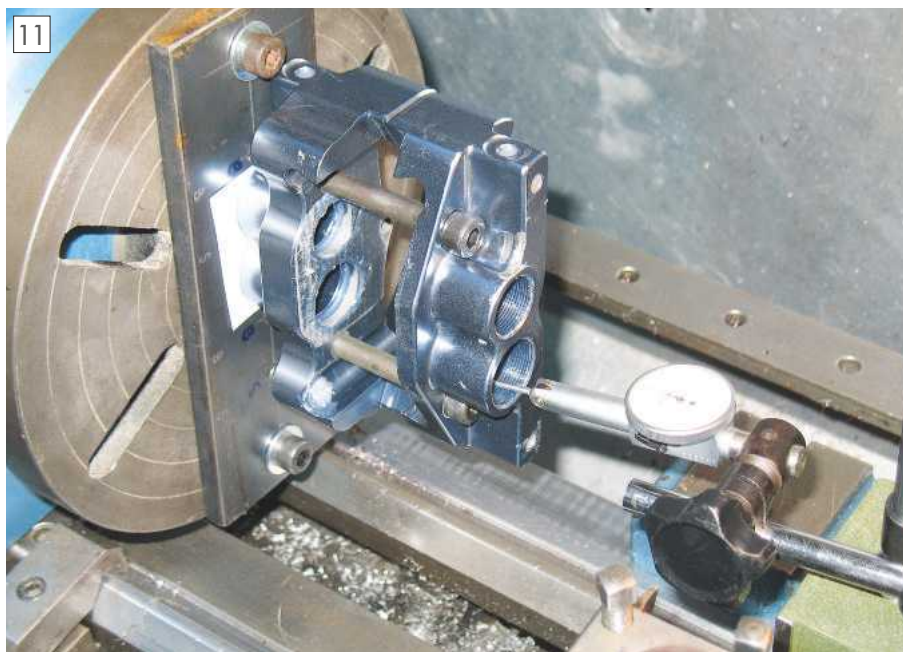
After I got the lathe into my workshop, close inspection showed that mechanically it was in very good condition. There was no rust or other degradation. It was evident that the lathe was overdue for some routine maintenance as indicated by the amount of dirt removed from the apron seen in **photo 10**. I stripped the lathe down to its components, cleaned, lubricated and reassembled the machine. No repairs or replacement parts were required.

I didn't run the lathe until after the rebuild. The Denford has proven to be a very good machine tool. It has been used to produce a variety of different projects to a high level of precision. Some of these have appeared as articles in this magazine. I have used it to make tools, fix shower doors, modify racing kart brakes (**photo 11**) and the ball-in-the-cube seen in **photo 12**. It's just the right size to do a multitude of work.

I discovered that Denford still exists as a company. Although they no longer manufacture the Viceroy T.D.S lathe or sell parts, they still retain the drawings. They also have a website with an area for providing user information. I proposed that they allow me to post photos and information on the rebuild of my lathe for the benefit of others. Denford agreed and opened a new 'projects' area where I could post information. As I stripped down and rebuilt the lathe, I posted a record of my work. This site is now the only place on the Internet where owners of Denford lathes can obtain detailed information about how to rebuild a Viceroy T.D.S lathe and is now the prime reference for other Denford lathe owners. The website also includes examples of a range of projects I have completed on the Denford. Others have followed and have also used the site to showcase their work.



Ball in a cube made entirely on the Viceroy lathe.



Setting up to rebore a racing kart brake caliper.

The Lathe History

I decided to trace the origin of this particular Denford Viceroy lathe. I discovered it was first imported into New Zealand by a trade qualified fitter and turner who did maintenance at a bottling factory in the city of New Plymouth. His job would have provided him with the justification for obtaining the approvals and the foreign currency to import a lathe and accessories.

The Denford wasn't used for factory maintenance, it was used to make model steam engines. The lathe remained with the original owner until he passed away.

As a result of the skills of the owner and the type of work, the lathe has had relatively light use over its life time. The owner's estate sold the lathe to a family friend who then on-sold the lathe to an Engineer. The Engineer used the lathe for two years to machine kart racing engines. It was from this Engineer that I purchased the lathe.

Since finding my Denford lathe, I have only seen three other examples in New Zealand. None of the other Denford lathes seen equaled the condition of mine. Denford lathes, good or bad, are truly rare in this country.



New motor mount.

VFD Conversion

The most significant improvement is the installation of an electronic variable frequency drive. I soon found that the standard 750W motor was rather underpowered, especially when using carbide tooling. Carbide tooling requires higher speeds and feeds than HSS to give the sort of finish seen in the glossy brochures. I also found that changing the belts to change speeds was inconvenient so I then decided to fit a VFD. This would provide more power and infinite speed variation. I managed to source an ABB industrial VFD at a heavily discounted price and an ABB 1.2kW motor was both new and free. I made new pulleys for the poly-vee belt on the Denford and I also fabricated a new motor mount. The standard motor mount is supported on three points and has rather too much flex to be suitable for use with poly-vee belts which require good alignment for proper operation. The new motor mount shown in **photo 13** is supported on four points and is much more rigid. The motor is fitted with a centrifugal fan that provides a constant flow of cooling air. An aluminum shroud was spun on the Denford to make a cowl for the cooling fan motor (**photo 14**).

The installation of the VFD resulted in the replacement of the entire electrical protection and control system. I made an additional control panel mounted on the headstock. Although the lathe has been heavily modified, the additional control panel in **photo 15** is the only external indication of the change.

The VFD conversion made the lathe quieter, smoother and more powerful but not over powered. The Viceroy was available with a factory option to have a 1.5HP motor intended for industrial users. The reduced vibration of the poly-vee belt noticeably improved the surface finish of turned work. The extra power made it easier to drive carbide tooling at the depth of cut and speeds needed to make them work properly. Changing the speed at the turn of a knob makes the lathe much more convenient to use.



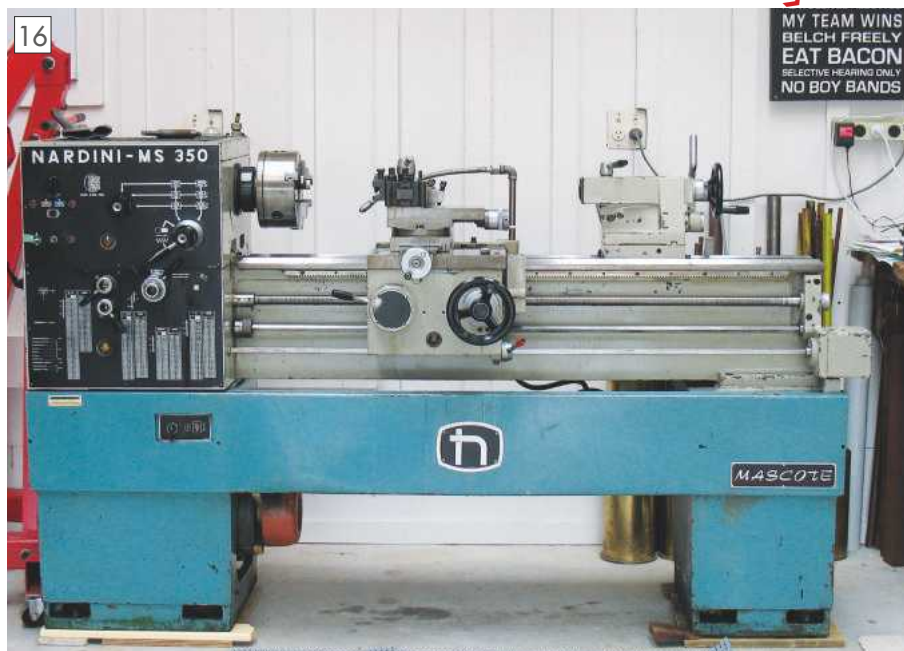
Spinning a motor cowl.

The Next Lathe

Within a year or two of finding the Denford, I started a search for another lathe. It's not that I was in any way unhappy with the Denford but I wanted something at least as good and slightly larger. After searching for over 7 years, I eventually found a lathe that was better than the Denford in most respects. It is a Brazilian made Nardini MS350 seen as delivered in **photo 16**. It is a high quality small industrial lathe originally purchased by a University research lab in South Africa. This class of lathe in such good condition is incredibly rare in New Zealand.



New Zealand workshops operate under strict rules.



The Brazilian made Nardini lathe.



The VFD panel with the most used controls.

I purchased the Nardini at the beginning of 2014. Like the Denford, I have stripped down the lathe and rebuilt it. Like the Denford, it is a good quality lathe in very good condition. I am currently in the process of fitting a 4kW motor and VFD to the Nardini. This will convert the lathe from 3 phase 400VAC to single phase 220VAC. The electronic drives now available are cheap enough to make such a conversion economically viable.

I am using the Denford to make new pulleys for the Nardini (**photo 17**) and other parts for the Nardini VFD conversion. In some ways the Denford is more capable than the Nardini. It has more accessories and is the right size for most of my work. I intend to keep both the Nardini and Denford lathes. The Denford is just too useful to let go.

The Future

My interest in metal work spans my life time but it has only been recent years that I have been able to fit out a reasonable workshop. I have a retirement plan to build a miniature model steam traction engine. A significant number of English built traction engines were brought to New Zealand. A surprising number have been preserved so there are a number to choose to model. The Denford will be suitable for machining many of the parts but the Nardini will have the size and power to make the larger items. The making of traction engine will be a kind of return to the making of the steam engine at school. ■



A poly-vee pulley being made for the Nardini on the Viceroy.

Improving ER Collet Run-out to Near Zero

Richard Gordon discovers a simple step to improve cutter concentricity.

Testing

I decided to test a 6mm diameter carbide shaft in a ¼ inch collet (as this put the clamped diameter in the middle of the collet capacity) and measured the run-out as per **photo 1**. I was able to achieve between 0.02mm and 0.03mm total indicated run-out (T.I.R.), no better.

ER collets were originally created in 1973 by the Swiss company REGO-FIX (**ref 1**). They claim their collets, at 6mm diameter, will achieve a concentricity of 0.01mm (T.I.R.) and the DIN standard is 0.015mm. (They also make an ultra precise collet at 0.005mm.) So, actually I wasn't doing that bad with my cheap collets at 0.02 to 0.03mm.

I did try gently tapping the side of the carbide shaft to see if I could improve the run-out, but to no effect, and with a small cutter, this wouldn't be practical.

Simple Fix

So, I trawled the internet for a solution. Quite a few options were suggested, such as the high precision version of the collets, using better ER tightening nuts and also nuts with ball bearings between the threaded part and the collet face (as the collet does not rotate when tightened). However I did come across a Japanese company called Yukiwa Seiko Inc. who make a very wide range of tool holding equipment. They make a collet based holder with an adjuster system that can get to a claimed T.I.R. of 0.002mm at the shank (**ref 2**).

They achieve this by obviously well made hardware but after the collet is tightened, a special clamping ring is put around the collet nut. A DTI set up as in **photo 2** and the clamp is moved to the highest run-out position and a bolt in the clamp is tightened to apply a pressure to counter the run-out. The clamp is then removed and the improved run-out is achieved. The clamp can be seen in photo 2. It appears this makes use of the fact that there is clearance in the tightening nut thread and the nut can be very slightly shifted to correct any run-out caused during tightening.

Although this is not an ER type collet system, it looked quite similar so I thought I would try this out on my collets.

First I checked the T.I.R. of the ER holder bore, which was 0.00mm as best as I could measure, which was a good start. Then I put the same set up together as photo 1, got 0.03mm T.I.R. and I thought about how to make such a clamp adjuster. Before that, I

I've used ER16 and ER25 collets for many years and always been impressed with their strong grip and wide range. Their accuracy has tended to be quite good – typically 0.02 to 0.03mm total indicated runout (T.I.R.) but variable. Sometimes no visible run-out (so I don't check it) and other times I can see its not quite right and I re-assemble, usually correcting the issue. I always thought this was due to buying cheap Chinese collets. However, the need to cut an accurate width slot in one pass necessitated some concentricity investigations as 0.03mm T.I.R. was too much.



tried tapping the nut at the highest T.I.R.. To my amazement, even though the nut was quite tight, I could reduce the T.I.R.. After a few taps, I had achieved almost 0.00mm T.I.R.. This is in contrast to tapping the carbide rod, which did not improve the T.I.R..

I tried a small milling cutter and again, I could achieve the same near zero T.I.R.. at the root of the cutter (**photo 3**). I also tried a few other sizes and could get good improvement in all, typically achieving 0 to 0.01mm T.I.R..

I then tried the same thing with my ER25 collet in my CNC 4th axis. This is usually more consistent than the ER16 sets and achieved 0.01mm immediately with a 10mm shank cutter, photo 3. Again, I was able to reduce this to near zero with a few light taps to the nut in the appropriate place.

was needed to improve the concentricity of the ER collet system. I hope this is of use to others, or perhaps you knew this already!? By the way, I don't think this will correct for any significant errors in the spindle, nut or collet, it just re-positions the nut back to the correct concentric position after tightening. If you are still finding it difficult to achieve 0.01mm T.I.R. or less, then check for cleanliness and try rotating the collet 180 deg (easier said than done, I know). If still no improvement with multiple collets, try another ER nut - I prefer the hex ones rather than the C spanner where available. ■

Conclusions

I never bothered with the clamp, a few light taps to the nut at the indicating high position of the cutter is all that I found

REFERENCES

1. <http://www.rego-fix.com/collets/ercollet-con.asp>
2. http://www.yukiwa.co.jp/e/ts/sgc_04.php#1



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The For Inverted Parting Tool Holder



Three sizes of Swarf Buster to suit different jobs. Top to bottom: general work, Myford Tee-slots, Unimat Tee-slots.

Who ya gonna call? Swarf Buster!



Ed Corley offers a quick solution to the endless spread of swarf.

This is possibly the simplest tool I have ever made, yet it gets used almost every time I do anything in the workshop. The concept is very adaptable and you can use whatever is available. There are two aluminium or plastic tubes, one inside the other: the inner one is a bit longer and has a couple of rare earth magnets attached to one end, the outer one is plugged at the bottom. Stick the business end (the plugged end) of the outer tube into a pile of swarf and push the magnet down. It attracts the swarf. Take the tool to the bin, pull the magnet up and the swarf falls off. Simple.

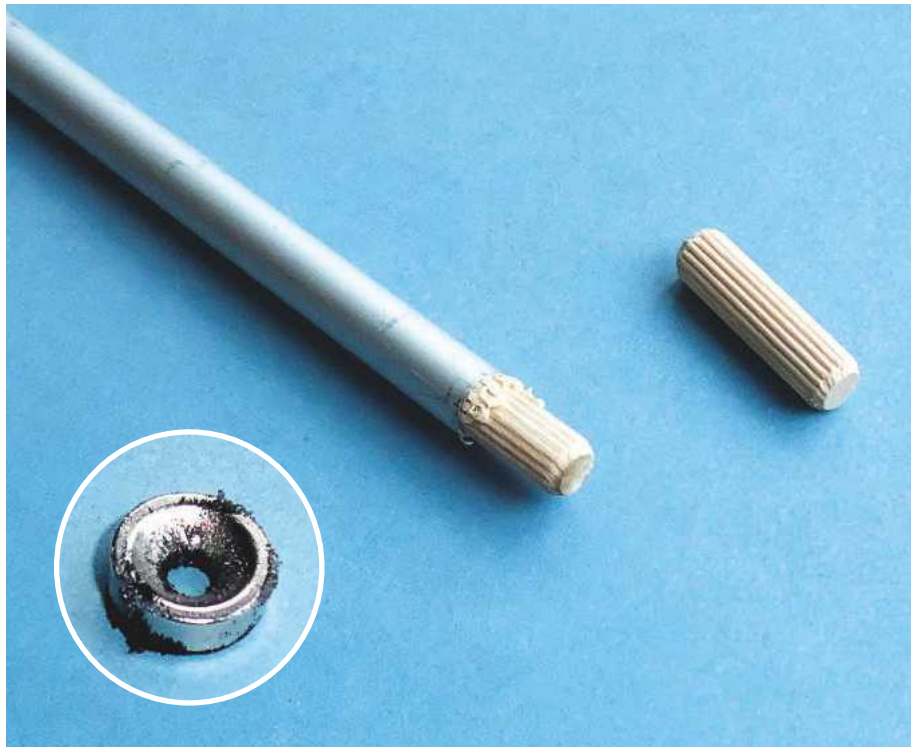
Using a magnet to pick up swarf is nothing new, and I don't claim to have re-invented the wheel. However, magnetic pick-up tools that have a release feature



A load of swarf picked up in seconds, ready for the bin.

can be expensive and the ones in my workshop are cheap and took minutes to make. The photos are self-explanatory and the three sizes I use are in **photo 1**. The bigger one is made with aluminium tubing from B&Q with a piece of clear plastic from a notebook held in place by tough packing tape which can be replaced when damaged. The middle one is almost embarrassing in its simplicity: it is an old Biro for the outer piece and a 2mm magnet glued to an offcut of aluminium rod for the inner. It is perfect for the Tee-slots on my Myford. The smallest tool is made from K&S Alloy tubing plus a length of 2mm plastic rod and is for the Tee-slots on a Unimat, again using a 2mm magnet. If you are picking up fine swarf, such as that produced from turning iron castings, it can follow the magnet upwards as you withdraw it: put an O-ring or rubber band around the middle of the outer tube to stop it.

While the tube-and-magnet tool is simple, there is an even more basic way to collect swarf that many readers will already know, which I include for the sake of completeness. Put your magnet in a plastic bag, reach inside and hold it with your fingertips. Put another bag over your hand. Pick up the swarf. Hold the whole mess over a bin and peel off the outer, swarf, bag, leaving it inside-out and drop it into the bin. ■



The biggest tool in photo 1 uses a magnet with a countersunk hole through the centre (inset) and a wooden dowel forced into the inner piece. When all the way in, make a pilot hole for a small woodscrew.



This is the outer tube. A small piece of tough vinyl cut from a school notebook cover is held over the end by ordinary brown packing tape.



With the magnets screwed in place and the end cover secure, your new tool is ready to assemble. I used two magnets, choose according to what is available.

This one has a 2mm magnet inside an old ballpoint pen case and works brilliantly. Engineering on a budget!



On the **Wire** **NEWS** from the World of Hobby Engineering

Midlands Model Engineering Exhibition

This year the Midlands exhibition will run from Thursday 15 to Sunday 18th October.

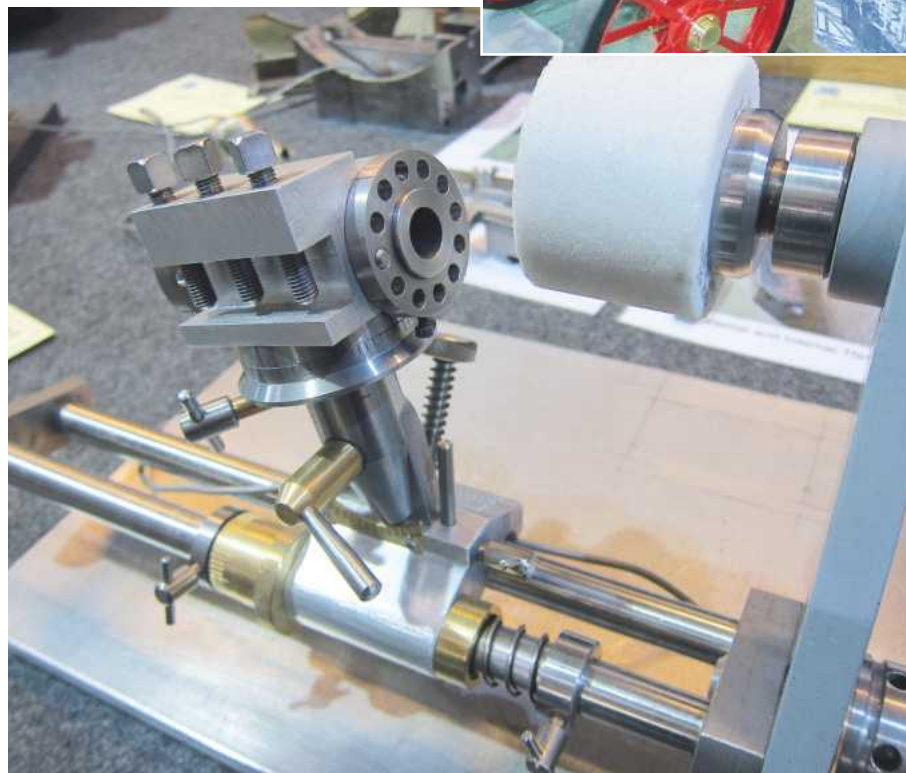
The Midlands Model Engineering Exhibition is shaping up to be the largest to date, at the time of going to print 52 specialist suppliers are booked to attend. In addition to this 32 clubs/societies will also be present displaying their members work.

Attractions for this year's exhibition include the Len Crane Display which celebrates the life of Len Crane, one of the Exhibition's founding supporters and a judge for many years. The tribute will feature his 3" scale Burrell Traction Engine Briggitte which was awarded the Duke of Edinburgh Trophy in 1971 and the railway locomotives he built.

Polly Model Engineering will be presenting a special display to commemorate John Clark, designer of the extensive range of model steam locomotives based on his original Polly design of which many hundreds have been built.

As always there will be workshop activities and free lectures from the experts. Advance tickets are available on line at www.midlandsmodelengineering.co.uk

Online ticket prices offer a saving over on the door - £9 for an adult, £8 senior citizen, £5 for a child and with reduced rates for families.



Bristol Model Engineering and Hobbies Exhibition

The Bristol Exhibition will be held at Thornbury near Bristol on 14 to 16 August. As in previous years, four halls of the Thornbury Leisure Centre will be filled with a wide range of trade stands for tools and materials together with models from clubs, societies and individual model engineers from which to draw inspiration.

As well as the numerous clubs and societies exhibiting their members' models there will be a number of new private exhibits together with displays commemorating the railways in war and the 150th anniversary of the Hunslet Engine Company of Leeds.

For more information and advance purchase of our 'Queue Hopper Tickets' visit the exhibition website www.bristolmodelengineers.co.uk/Exhibition/exhib.htm



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BORING TOOLS SET 3/8" & 1/2"  3/8" Was: £15 1/2" Was: £18 NOW: £10	CENTRE FINDER SET  Was: £13 NOW: £10	CLAMP & DIAL GAUGE  Was: £50 NOW: £33	DRILL PRESS VICES  DP80 Was: £15 NOW £13 DP100 Was: £18 NOW £15 DP125 Was: £26 NOW £22
ENGINEER SQUARES  2" Was: £5 NOW £4 3" Was: £5.30 NOW £4.40 4" Was: £6 NOW £5 6" Was: £9.40 NOW £7.80 12" Was: £29.50 NOW £24.60	HAND E ARBORS  Was: £76 NOW: £60	HORIZONTAL SCALES  4" / 100mm Was: £29 NOW £24 6" / 150mm Was: £32 NOW £27 8" / 200mm Was: £42 NOW £35 12" / 300mm Was: £51 NOW £43	HSS TOOL STEEL Square: 1/8" x 2.5" Was: £2.30 NOW £1.90 1/4" x 6" Was: £7.80 NOW £6.50 5/16" x 2.5" Was: £4.70 NOW £3.90 Round: 1/4" x 4" Was: £4.40 NOW £3.70 1/2" x 6" Was: £14.50 NOW £12.00 5/8" x 4" Was: £14.20 NOW £11.90 Other Sizes Available
INDEXABLE LATHE TOOLS  8mm Was: £46 NOW £37 10mm Was: £50 NOW £40 12mm Was: £61 NOW £48 16mm Was: £68 NOW £54	INTERNAL BORE GAUGES  Was: £24 NOW: £19	K SERIES VICE K SERIES 100 Was: £67 NOW £56 K SERIES 125 Was: £78 NOW £65 K SERIES 150 Was: £93 NOW £78	KEY DRILL CHUCK & ARBOR  MT1- 0.6-6mm Was: £13 NOW £10 MT2- 1-10mm Was: £15 NOW £13 MT3- 3-16mm Was: £35 NOW £29
LATHE CARRIERS Bent & Straight Tail  1/2" Was: £3.80 NOW £3.20 3/4" Was: £4.50 NOW £3.70 1" Was: £5.30 NOW £4.40 1.5" Was: £7.50 NOW £6.20 2" Was: £11 NOW £9	MAGNETIC BASE  Was: £14 NOW: £12	MAGNETIC BASE & DIAL GAUGE Metric or Imperial  Was: £50 NOW: £32	MEASURING TOOL SET  Was: £46 NOW: £36
MICROMETER SETS  Was: £80 NOW: £66	MULTI HEAD LIVE CENTRES  MT2 Was: £99 NOW £83 MT3 Was: £106 NOW £88	POZI LOCK COLLET SET with 4 collets (Metric/Imperial)  MT2, MT3, R8 Was: £123 NOW: £99	SLITTING SAW ARBOR  Was: £14 NOW: £11
T7 TILTING TABLE  Was: £87 NOW: £72	TOOLMAKER CLAMPS  1" Was: £4.90 NOW £4.10 2" Was: £5.60 NOW £4.60 3" Was: £8.40 NOW £7.00 4" Was: £9.10 NOW £7.60 5" Was: £9.90 NOW £8.20	TRANSFER PUNCHES  Letters A-Z Was: £16 NOW: £13	VERTICAL SCALES  4" / 100mm Was: £35 NOW £29 6" / 150mm Was: £40 NOW £33 8" / 200mm Was: £46 NOW £38 12" / 300mm Was: £67 NOW £56

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CHESTER

Machine tools

Clwyd Close
Hawarden Industrial Park
Hawarden, Nr Chester
CH5 3PZ

ORDER LINE: 01244 531631

Free Delivery on all tooling and accessories (showing the  badge) to UK Mainland addresses.

20pc END MILL / SLOT DRILL SET

Was: £112
NOW: £89



3 JAW SELF CENTERING CHUCK - 80mm

Other sizes are available

Was: £53
NOW: £43



38pc BRAZED CARBIDE LATHE TOOL SET

1/4" Was: £29 **NOW £23**
5/16" Was: £32 **NOW £25**
3/8" Was: £38 **NOW £30**
1/2" Was: £43 **NOW £34**



4 JAW INDEPENDENT CHUCK

80mm Was: £77 **NOW £64**
100mm Was: £80 **NOW £67**
125mm Was: £84 **NOW £70**
160mm Was: £127 **NOW £99**



4 JAW SELF CENTERING CHUCK

80mm Was: £78 **NOW £65**
100mm Was: £87 **NOW £73**
125mm Was: £96 **NOW £80**
160mm Was: £119 **NOW £99**



BORING HEAD SET MT2 & MT3

Was: £55
NOW: £43



COLLET CHUCK SET MT2, MT3 & R8 (Metric/Imperial)

Was: £114
NOW: £90



ECONOMY LIVE CENTRE MT2 & MT3

Was: £29
NOW: £19



END MILL SETS

5pc Was: £22 **NOW £15**
6pc Was: £35 **NOW £25**



ER COLLET CHUCKS

MT2 / ER25 Was: £88 **NOW £74**
MT3 / ER32 Was: £96 **NOW £80**
R8 / ER25 Was: £91 **NOW £76**
R8 / ER32 Was: £100 **NOW £83**



ER LATHE COLLET CHUCK 80mm ER25 or ER32

Was: £48
NOW: £39



FLY CUTTER SET (Inc Tool Steel) SPARE TOOL STEEL ALSO AVAILABLE

Was: £21
NOW: £16



HOBBY TILTING VICE

3" Was: £39
NOW: £32
4" Was: £47
NOW: £39



PARTING TOOL

Each Parting Tool is Supplied With HSS Blade & Spanner



9/16" Was: £19 **NOW £15**
3/4" Was: £21 **NOW £16**
8mm Was: £13 **NOW £10**

PRECISION LIVE CENTRE

MT1 Was: £37 **NOW £30**
MT2 Was: £45 **NOW £37**
MT3 Was: £53 **NOW £44**



SMALL VERTICAL SLIDE (Ideal for Conquest Lathe)

Was: £83
NOW: £66



V80 SERIES VICES 80mm Jaw Width

Was: £65
NOW: £54



WORK LAMPS

Magnetic or Screw Type Base

Was: £46
NOW: £33



EX DEMONSTRATION MACHINES CURRENTLY AVAILABLE

Conquest Mill Imperial x 2, Conquest Mill Metric x 2, Micro Mill Metric, Micro Drill Metric x 4, Micro Drill Imperial x 4, Micro Mill/Drill Metric, D13 Drill Press x 2, Conquest Lathe Imperial x 2, Cobra Lathe Imperial x 2, Conquest Super Lathe Metric x 2, 3 Ton Arbor Press x 2, DB7VS Lathe with Stand Imperial, DB10VS Lathe Imperial x 2. Parts Washer, Small Toolbox, Crusader VS Lathe Metric, Blue Stand.



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CONQUEST LATHE

325mm Between Centres, 180mm Swing, Variable Speed, Easily Portable, Thread Cutting, Lathe Tools, 80mm 3 Jaw Chuck, Quick Change Toolpost.



Was: £582

NOW: £399

CONQUEST SUPER LATHE

325mm Between Centres, 180mm Swing, Digital Spindle Readout, Thread Cutting.



Was: £684

NOW: £450

920 LATHE

500mm Between Centres, 240mm Swing, Thread Cutting Gearbox, Thread Cutting Dial.



Was: £864

NOW: £699

DB8VS LATHE METRIC

400mm between centres, 210mm Swing, Spindle Speed Range 50 - 2000rpm, MT3 Spindle. Includes 100mm 3 & 4 Jaw Chucks, Steadies, Digital Speed Readout.

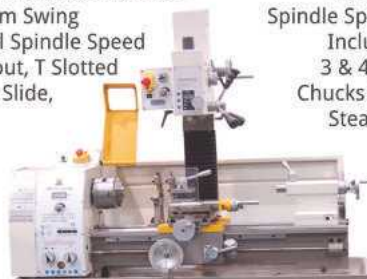


Was: £1236

NOW: £945

DB11 VS WITH MILL HEAD

700mm Between Centres
280mm Swing
Digital Spindle Speed Readout, T Slotted Cross Slide, Variable Spindle Speed. Includes 3 & 4 Jaw Chucks And Steadies



Was: £2832

NOW: £2199

CRAFTSMAN LATHE

570mm Between Centres, 300mm Swing, 36mm Bore, 2 Axis Digital Readout, Back Gear, Powered Crossfeed, 160mm 4 Jaw Chuck. Includes Stand



Was: £2808

NOW: £2248

CRUSADER LATHE

810mm Between Centres
300mm Swing, Range Of Speeds: 65-1810rpm, Hardened & Ground Gears, Induction Hardened Guideways



Was: £2616

NOW: £2450

CRUSADER DELUXE

810mm Between Centres, 300mm Swing, 38mm Spindle Bore, 1.5Hp Motor, Fully Geared Head, Professional Camlock Spindle, 2 Axis Digital Readout



Was: £4020

NOW: £2999

MODEL B 3 in 1

520mm Between Centres, 420mm Swing, 20mm Bore, MT3 Spindle, Taper Bearing Headstock, 3 Jaw Self Centering Chuck with External & Internal Jaws



Was: £1260

NOW: £984

CENTURION 3 IN 1

420mm Swing
28mm Spindle Bore
MT3 Spindle
Powered Crossfeed

Standard Accessories:
Drill Chuck & Arbor
Combined Vice / Compound Slide
Separate Motor for Lathe & Mill



Was: £1704

NOW: £1364

CENTURIAN 3 in 1 LONG BED LATHE

800mm Between Centres, 420mm Swing, 28mm Bore, MT4 Spindle, Powered Crossfeed, Leadscrew Guard.



Was: £1920

NOW: £1550

CONQUEST SUPER MILL

13mm Max Drilling Capacity, 270mm Max Distance of Spindle to Table, MT3 Spindle Taper, 460 x 120mm Table Size.



Was: £684

NOW: £474



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ORDER LINE: 01244 531631

Free Delivery on all tooling and accessories (showing the  badge) to UK Mainland addresses.

CHAMPION 16VS MILL

Travel: 160 x 280 x 200mm
500 x 140mm Table
Variable Spindle Speed
600w Motor
MT2 Spindle
Drawbar
Tilting Head
Drill Chuck & Arbor



Was: £912

NOW: £599

CHAMPION 20VS MILL

Drilling Capacity: 20mm
Table Size: 700 x 180mm
Speed Range: 50 - 2200rpm
MT2 Spindle
H/L Gear
Variable Speed
Quill Feed
Head Tilts Left to Right



Was: £1116

NOW: £836

CENTURY MILL

32mm Drilling Capacity
820 x 240mm Table
Speed Range: 95 - 1600rpm
MT3 Spindle

Standard Accessories:
Drawbar, V100 Vice,
Face Mill Cutter,
Drill Chuck & Arbor



Was: £1356

NOW: £999

EAGLE 30 MILL

32mm Drilling Capacity
730 x 210mm Table
Speed Range: 125 - 2500rpm
MT3 Spindle

Standard Accessories:
Drawbar, Tilting Vice,
Face Mill Cutter,
Drill Chuck & Arbor



Was: £1440

NOW: £1100

LUX MILL

Drilling Capacity: 32mm
Table Size:
820 x 240mm
Speed Range:
95-1600rpm
MT4 / R8 Spindle
Drawbar, V100 Vice,
Face Mill Cutter,
Drill Chuck & Arbor



Was: £1860

NOW: £1488

EAGLE 25 MILL

25mm Drilling Capacity
Table Size: 190 x 585mm
Speed Range: 90-2150rpm
MT3 Spindle Taper
Face Mill Cutter
Drill Chuck & Arbor
Tilting Vice
Head Swivels 360°
(Stand not included)



Was: £1188

NOW £1000

626 TURRET MILL

Drilling Capacity: 20mm
Table Size: 6" x 26"
Speed Range:
190-2100rpm
MT3 / R8 Spindle
Drawbar, Worklight.

Shown with optional power feed
& Digital Readout



Was: £2364

NOW: £1548

SUPER LUX MILL

Drilling Capacity: 45mm
Table: 240 x 820mm
Speed Range: 95-1600rpm
R8 Spindle
Drawbar,
2 Axis Digital
Readout, Drill
Chuck & Arbor
Stand Included



Was: £2160

NOW: £1997

MODEL T TURRET MILL

Table Size: 240 x 800
ISO30 Spindle
Variable Spindle Speeds
3 Axis Digital Readout
Work Lamp
Power Feed
Horizontal Arbors
Ground Column
Slideways



Was: £6168

NOW £4575

MODEL T MILL SUPER

MT4 Spindle, Table Size: 1200 x
280mm, 3 Axis Digital Readout,
Lamp, Gear Driven Vertical
Milling Head, Big 120mm
Spindle Travel



NEW MODEL

£6168

D SERIES DRILLING MACHINES

D13
Was: £102 **NOW £92**
D13R
Was: £174 **NOW £139**
D16
Was: £258 **NOW £186**
D19
Was: £306 **NOW £226**
D20
Was: £294 **NOW £245**



H110 BANDSAW

Max Cutting Capacity
@ 90° Round: 110mm
Square: 100x150mm
Max Cutting Capacity
@ 45° Round: 100mm
Square: 85x65mm



Was: £366

NOW: £299

HV128 BANDSAW

Max Cutting Capacity
@ 90° Round: 5" / 128mm
Rectangle: 115x150mm
Blade Size: 1/2" x 64.5"
Speed Range: 65, 95,
165rpm



Was: £582

NOW: £329

HV128-S BANDSAW

Max Cutting Capacity
@ 90° Round: 5" / 128mm
Rectangle: 128x150mm
Blade Size:
12.7x0.65x1635mm
Speed Range:
20, 29, 50mm/min



Was: £888

NOW: £599

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For those who can not make it to our Winter Open Week (30th Nov - 4th Dec),
we will be at the London M.E.E at the Alexandra Palace
on 15th - 17th January.

SOFT JAWS

80mm
Was: £35 **NOW £29**
100mm
Was: £38 **NOW £32**
125mm
Was: £41 **NOW £35**
160mm
Was: £47 **NOW £39**



Other
Sizes
Available

BANDSAW BLADES



Carbon, 14TPI to fit H80 **£14.50**
Bi Metal 18TPI to fit H80 **£16**
Carbon, 18TPI to fit H110 **£12.60**
Bi Metal, 14TPI to fit H110 **£17.20**
Other Blades Available

STRAIGHT SHANK TWIST DRILLS



Available In Metric 1mm - 12.5mm
& Imperial 1/16" - 1/2"

END MILLS

Available In Metric & Imperial



5pc INDEXABLE REPLACEMENT TIPS

1/4" / 6mm Was £18.80 **NOW £15.60**
5/16" / 8mm Was £18.80 **NOW £15.60**
3/8" / 10mm Was £20.60 **NOW £17.00**
1/2" / 12mm Was £20.60 **NOW £17.00**
5/8" / 16mm & 3/4" / 20mm
Also Available



INDIVIDUAL STEEL FOR FLY CUTTERS



Was: £2.13
3/16" **£1.80** Was: £3.92
5/16" **£3.30** Was: £2.78
1/4" **£2.30**
Fly Cutters Sold Separately

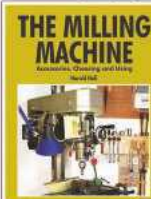
CONQUEST LATHE TOOLPOST HOLDERS



Was: £12.24
£10 each

SLOT DRILLS

Available In Metric & Imperial



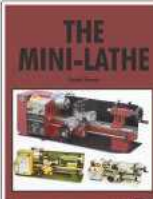
The Milling Machine

This book deals with the process of choosing & using a milling machine & its accessories. In addition to the machine itself, the accessories include cutters, cutter chucks, clamps, vices, angle plates, rotary tables etc.

WORKSHOP PRACTICE SERIES: 49



£ 6.95



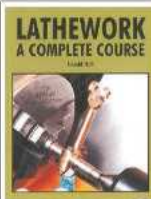
The Mini-Lathe

This book is a complete course on using & improving this new generation of lathes. It explains everything from setting up & tuning the machine for best performance to using and 'tuning' the machine.

WORKSHOP PRACTICE SERIES: 43



£ 6.95



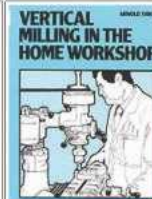
Lathework, A Complete Course.

This book assumes no previous experience & using the medium of 12 lathe turning projects will lead prospective model engineers through all the basic techniques needed to tackle ambitious projects.

WORKSHOP PRACTICE SERIES: 34



£ 7.50



Vertical Milling In The Home Workshop

This 3rd revised edition includes descriptions of many of the very wide range of operations possible with photographed examples, plus info on machines, accessories, cutters, chucks etc.

WORKSHOP PRACTICE SERIES: 2



£ 7.50



Screwcutting In The Lathe

One of the most useful functions of the modern lathe is its ability to cut any form of external & internal thread of any thread form, pitch or diameter within the overall capacity of the machine

WORKSHOP PRACTICE SERIES: 3



£ 7.50



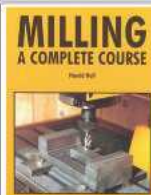
Milling Operations In The Lathe

One of the most popular titles in model engineering books for almost 60 years was milling in the lathe, which 1st appeared in the 1920's & continued in updated & revised editions until 1983. This book replaces it.

WORKSHOP PRACTICE SERIES: 5



£ 7.50



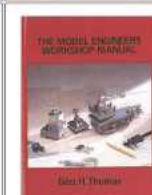
Milling A Complete Course

All of the projects within this book are extensively illustrated & include full workshop drawings. Once followed through, the reader will have amassed a wealth of practical skills.

WORKSHOP PRACTICE SERIES: 35



£ 7.50



The Model Engineers Workshop Manual

The 3rd book by highly respected author George Thomas will undoubtedly become the bible for both novice & experienced alike, containing over 300 pages on most aspects of machining.

WORKSHOP PRACTICE SERIES: 1



£ 26.35



CHESTER
Machine tools

**WINTER
OPEN WEEK
2015**

BELT & DISCS

1" x 5" Belt & Disc Sander
BELTS: Was: £8.40 **NOW £7.00**
DISCS: Was: £12.00 **NOW £10.00**
Both available in 80#, 120#, 180#, 240# Grit



4" x 6" Belt & Disc Sander
BELTS: Was: £8.40 **NOW £7.00**
DISCS: Was: £8.40 **NOW £7.00**
Both available in 80#, 120#, 180#, 240# Grit



COOLANT

Coolant / Cutting fluids are used in metal machining for a variety of reasons such as improving tool life, reducing workpiece thermal deformation, improving surface finish and flushing away chips from the cutting zone.

1 Litre WAS: £10.36 **NOW £8.60**
5 Litres WAS: £30.34 **NOW £25.00**
25 Litres WAS: £157.24 **NOW £131.00**
(25-1 Mix)

Don't forget we also sell Coolant Systems, hoses & Hose Fittings



30th Nov - 4th Dec 2015

CHESTER BRANCH ONLY
Free Tea, Coffee, Soft Drinks and Biscuits

BI-METAL HOLE SAWS

Items below 32mm / 1-5/16" have a 1/2" 20UNF bore.
Items above 32mm / 1-5/16" have a 5/8" 18UNF bore.

9/16" / 14mm £2.38	1-1/16" / 27mm £3.79	1-9/16" / 40mm £5.33
5/8" / 16mm £2.53	1-1/8" / 28mm £3.98	1-5/8" / 41mm £5.54
11/16" / 18mm £2.81	1-3/16" / 30mm £4.32	1-11/16" / 43mm £5.67
3/4" / 19mm £3.06	1-1/4" / 32mm £4.47	1-3/4" / 44mm £5.86
13/16" / 21mm £3.18	1-5/16" / 33mm £4.76	1-13/16" / 46mm £6.07
7/8" / 22mm £3.35	1-3/8" / 35mm £4.89	1-7/8" / 48mm £6.31
15/16" / 24mm £3.48	1-7/16" / 37mm £5.09	2" / 51mm £6.53
1" / 25mm £3.67	1-1/2" / 38mm £5.20	



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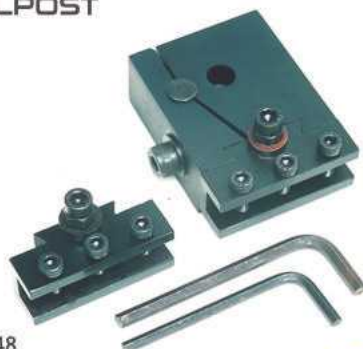
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CH5 3PZ

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SMALL QUICK CHANGE TOOLPOST



Was: £48

NOW: £40



ROTARY TABLES

100 Was: £208

NOW: £150



150 Was: £313

NOW: £170

DIVIDING PLATES AVAILABLE



MACHINE STANDS



BUY A STAND WITH YOUR MACHINE FOR ONLY £100 EXTRA inc VAT

(To suit: DB7, DB8, DB10, DB11, Champ16, Champ20, Lux Mill and Century Mill)

AUTO REVERSE TAPPING HEAD



TAP 7

Was: £293 **NOW £244**

TAP 12

Was: £351 **NOW £292**

TAP 20

Was: £619 **NOW £516**

SPARE COLLETS ALSO AVAILABLE 

1" X 5" BELT & DISC SANDER

Belt Size: 1" X 30" / 25 X 762mm
Disc Size: 5"
Motor: 0.3Kw / 0.41Hp
Belt Speed: 16.4m/s
Disc Speed: 3400r/min

Spare Belts & Disc Papers Are Available To Purchase Separately



Was: £66 **NOW: £49**

FLEXI DRIVE



Includes: Grinding Stones, Rotating Head, 5 X Chisels, Engraving Head, Deburring Stones, Diamond Burrs, Sanding Attachments 

Was: £114

NOW: £90

6" BENCH GRINDER

Motor: 0.33Hp / 0.25Kw
Speed: 2850rpm
Wheel Size: 150 x 20mm
Motor Shaft Dia: 12.7mm
Wheel Grit: 36#
Wheel Material: Al. Oxide / Wire



Was: £54 **NOW: £45**

TOOL SHARPENER

Speed: 140rpm
Wheel Size: 118.38mm
Motor: 0.1Hp / 0.07Kw
Includes Coolant Tray



NOW: £42

5x8" PROFESSIONAL WET/DRY WHEEL SHARPENER

Wet Speed: 320rpm
Dry Speed: 2850rpm
Wheel Size: 200x25mm
Motor: 0.33Hp / 0.25Kw



NOW: £138

ELECTRIC HOISTS



Was: £90

NOW: £72



HYDRAULIC PRESS



10T
Was: £210

NOW: £170

20T
Was: £294

NOW: £235

LIFTING CRANE



2T
Was: £426

NOW: £340

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E&OE



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QUICK CHANGE TOOLPOST & 5 HOLDERS



T-1: Was: £251 **NOW: £159**
T-2: Was: £341 **NOW: £190**

Each Set Includes a Square, Vee, Knurling, Parting & Boring Tool Holder
If purchased at the same time as a machine, this can be fitted prior to despatch.

TOOLHOLDERS ARE ALSO AVAILABLE TO PURCHASE SEPARATELY 

HOBBY COOLANT SYSTEM



Was: £99
NOW: £79



POWER FEEDS



Was: £289
NOW: £260



SC COLLETS

Metric and Imperial
3-25mm or
1/8" - 1"
or a mix of both.



ANY 10 FOR £39

R8 COLLETS



10 FOR £42

Metric and Imperial 3-20mm or
1/8" - 11/16" or a mix of both.



ER COLLETS

Choose From Our Range Of
ER16, ER25, ER32, ER40



ANY 10 FOR £80



STEP UP SLEEVES

MT1
Was: £16 **NOW £13**
MT2
Was: £21 **NOW £17**
MT3
Was: £36 **NOW £29**
MT4
Was: £62 **NOW £51**



REDUCING SLEEVES



MT2 Was: £4.80 **NOW £4.00**
MT3 Was: £6.40 **NOW £5.30**
MT4 Was: £12.90 **NOW £10.70**
MT5 Was: £19.25 **NOW £16**
R8-MT1 Was: £17.60 **NOW £15**
R8-MT2 Was: £19.25 **NOW £16**
R8-MT3 Was: £47 **NOW £39**



DIGITAL READOUT WITH 2 scales up to 1 metre in total



You can have a 2 axis digital readout for your lathe or mill for just £450. Ideal if you have the following machines: DB8VS, DB10 Super, DB11VS, DB11VS + Mill Head, Model B, Centurion 3 in 1, 626 Turret Mill, Champion 20VS, Lux Mill & Century Mill

(Buy with your new machine and we will fit it FREE)

NOW: £450

TOOL BOX SET



Each set comprises of:
TBT2006 Width: 660mm Depth: 322mm Height: 366mm
TBI2002 Width: 668mm Depth: 338mm Height: 212mm
TBR2003 Width: 680mm Depth: 435mm Height: 664mm

Was: £294 **NOW: £250**

POWERFEED & TRANSFORMER SET



Std Bench Mill
X Axis
Y Axis
Z Axis

Was: £370
NOW: £310

You can also upgrade your transformer to 2 outputs for an additional £10



Free Delivery

Available to standard UK mainland addresses excluding Channel Islands, Northern Ireland and parts of Scotland.

FREE PRIVATE ADVERTS

Subscribers, see these adverts five days early!



Machines and Tools Offered

■ WARCO MINOR MILL, Digital readout, Rotary table, machine vice, Clarkson chuck, Boring head, ER type collet chuck, clamp set, Warco stand, Single phase £800. **T. 01442 266050. Hemel Hempstead.**

■ MYFORD SYGMA large Bore super 7B LATHE ON Stand as new hardened bed. Many extras. in addition to standard kit, three phase 1hp motor and electronic controller ML750. Myford Dixon tooling Grip-tru Chuck and much more £4,950. **T. 020 8669 1480, Middlesex.**

■ HARRISON L6 three speed lathe, gap bed, Transwave convertor, some accessories £500 O.N.O. Buyer must collect. **T. 01543 275022. Cannock.**

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Making a cantilever tool for square tapping Part 2



This article will describe how to build a compact tool that will ensure that you achieve a thread that is square to the work piece, both small items as well as larger ones. A CAD model of the complete tool is shown below. The idea is to hold the tapping tool in a self centring chuck and this chuck again is held in parallel arms thereby ensuring a constant alignment with a horizontal plane at any position of the tool.

Mogens Kilde completes his unusual tool for accurately tapping holes that includes a neat self-centring mechanism.

The next step in the process was to make the jaws that will hold the tapping tool, to clarify these you can see the finished jaws placed in the collet in **photo 41**. The jaws are shown in **figures 9 to 12**.

First I sawed four billets (**photo 42**). All billets were milled to outer dimensions according to the drawings, it is very important to make these parts precisely to make a working collet, I managed to work the parts within $\pm 0.02\text{mm}$ (**photo 43**). Next all work pieces were placed in the vice using a v-block (**photo 44**). The groove in the v-block was a bit too long but I could hold the parts by placing a nut in one end of the v-groove. Now the 4.5mm cut of the 45 degree chamfer was milled using a fly cutter (**photo 45**).

All parts were turned over and the 8.5mm deep cut was made (**photo 46**). After this it was time to make the individual jaws according to the drawings, jaw number 4 is finished for now, but jaw number 1 had to have the M5 hole drilled and tapped (**photo 47**) and jaw numbers 2 and 3 had to be milled in accordance to their respective drawings (**photo 48**).

The next operation was to shorten a M5 grub screw to a length of 24mm, I have no photo of this work but **figure 13** will clarify where this screw is placed in the collet.

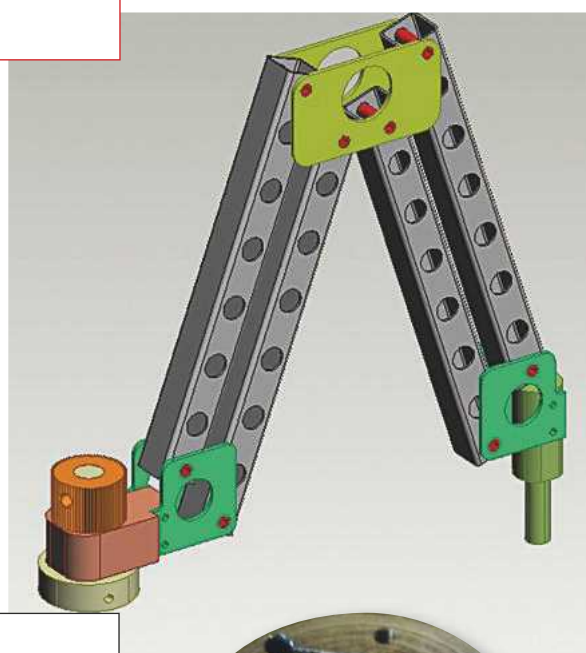
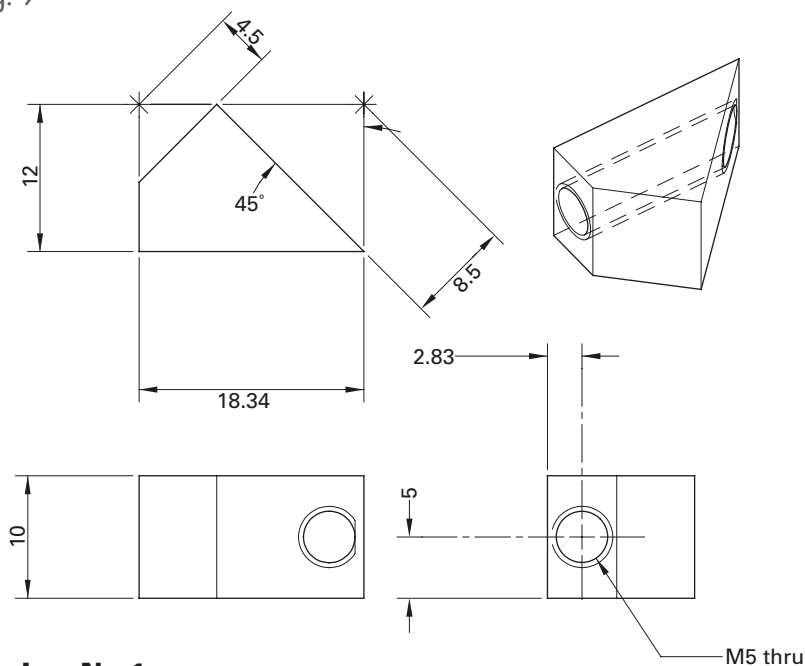


Fig. 9



Jaw No.1

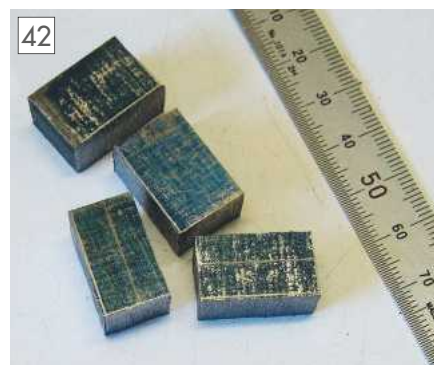
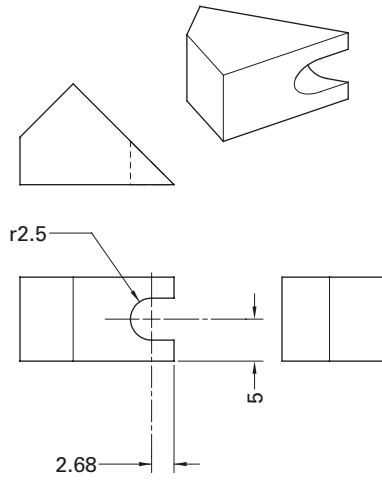
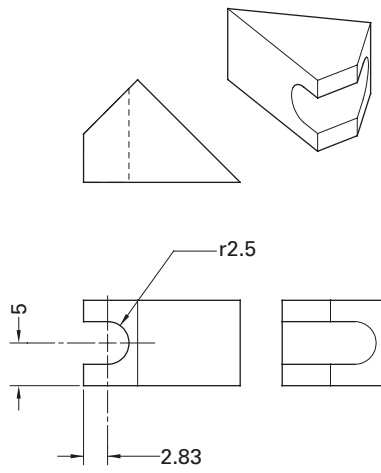


Fig. 10



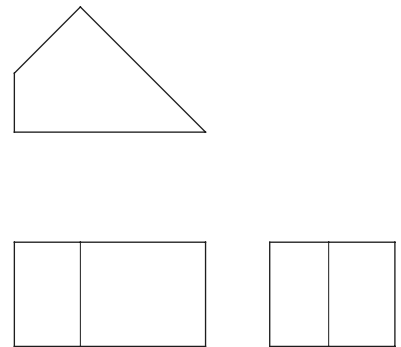
Jaw No. 2

Fig. 11



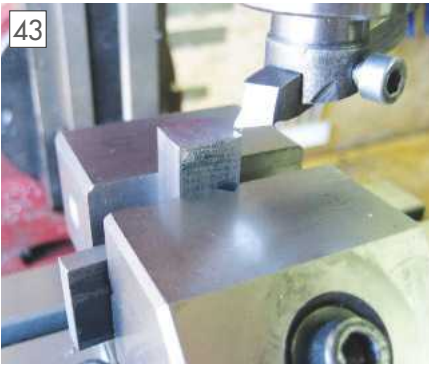
Jaw No.3

Fig. 12



Jaw No.4

43



44

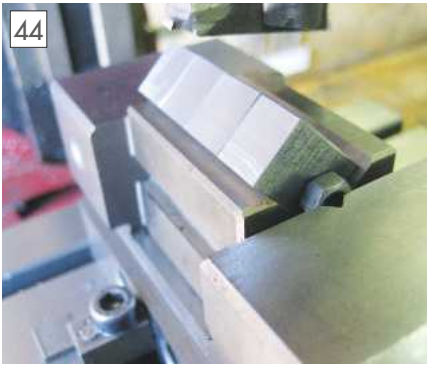
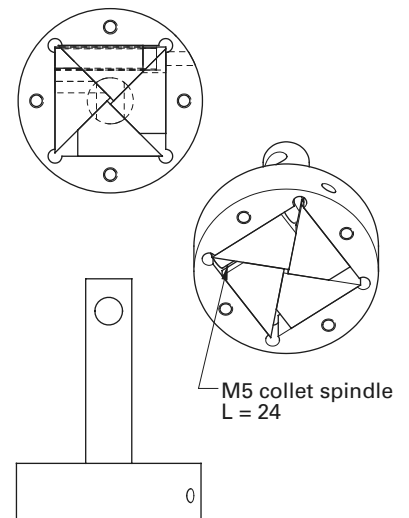
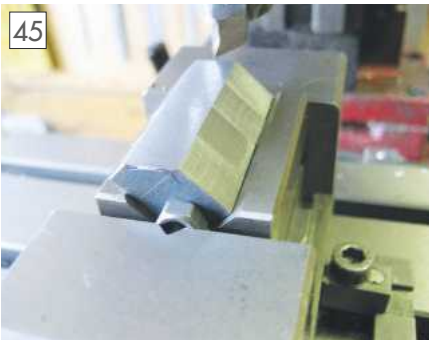


Fig. 13



Tap Arbor Assembly

45



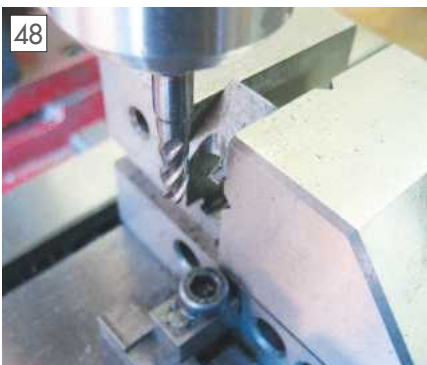
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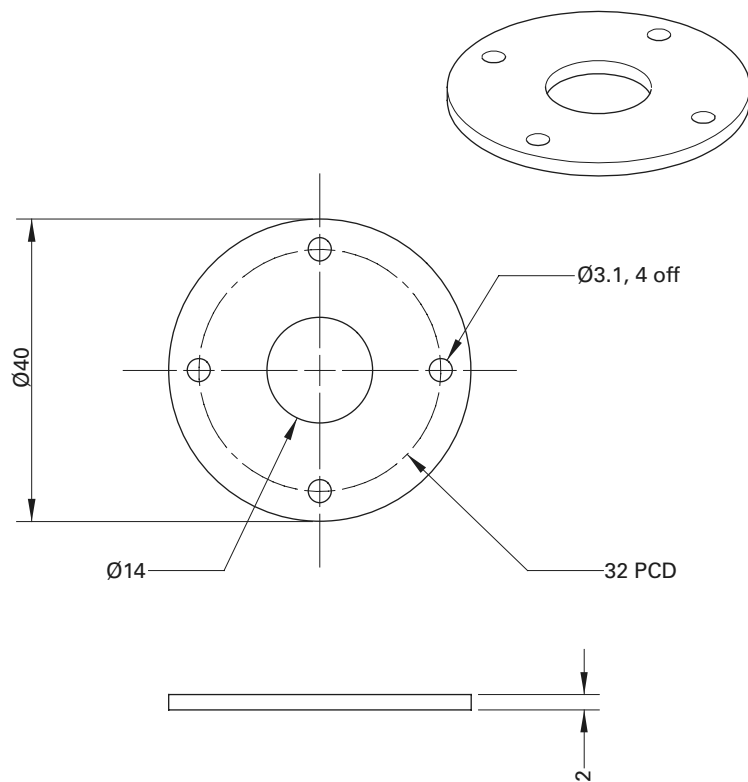
48



49



Fig. 14



Collet Cover

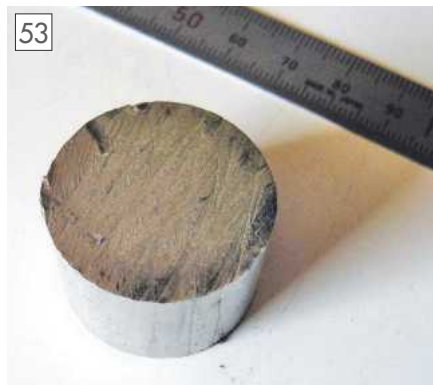
The next part to be made was the cover for the collet (**fig. 14**). This part was made from a left over cut when I made the housing for the collet, this was 40mm diameter mild steel. First I placed the blank in the lathe chuck (**photo 49**), the part was faced off to final dimension and the internal boring of 14mm was turned in the lathe (**photo 50**). Next the part was placed onto the mill bed and the four 3mm holes were located and drilled (**photo 51**).

Now the collet could be assembled and the function of the closing and opening could be checked (**photo 52**). As all parts needed to work to a close tolerance, I had to work a bit with removing sharp edges before a satisfying function was obtained.

The final part to make was the thumb nut (**fig. 15**). This part was made from aluminium so first a blank was cut (**photo 53**), again a little oversize according to the drawing and the part was faced to final measures (**photo 54**).

The 10mm centre hole was drilled in the lathe (**photo 55**) and the part was transferred to the vice on the mill and the 6mm hole was drilled through the part. The part was turned over and the M6 threaded hole was made (**photo 56**). The part was locked with a M6 x 6 grub screw onto a piece of 10mm steel rod and this setup was placed in the lathe so I could make the knurling on the outer surface (**photo 57**).

The thumb nut was assembled to the collet and the tool was finished (**photo 58**). Now I could make the first test run of my new tool and I must say I was very pleased with the result. ■



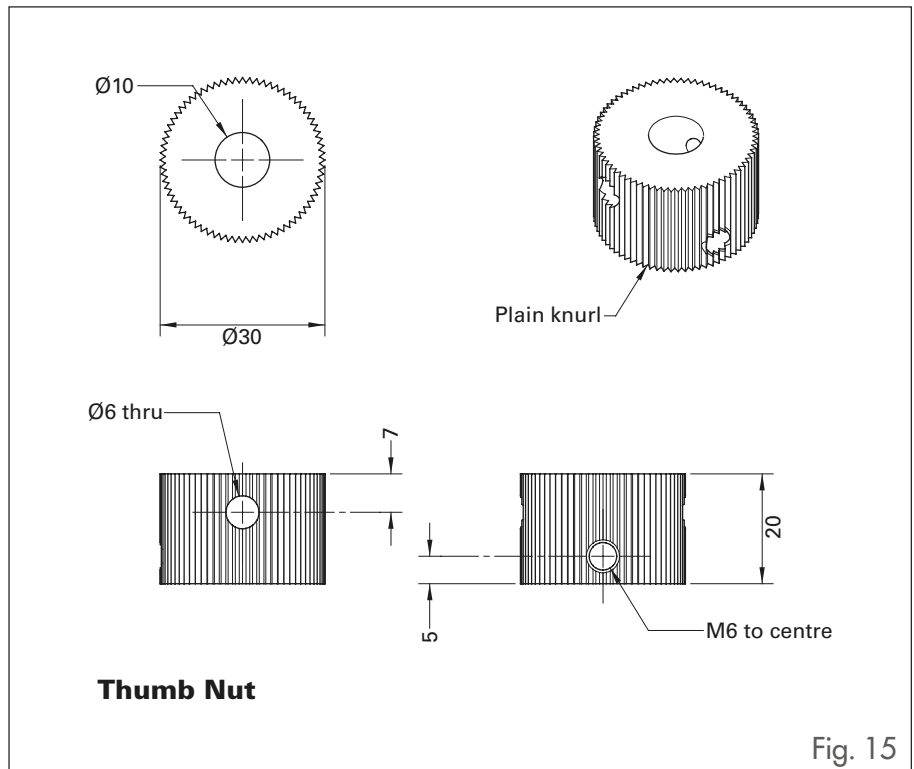
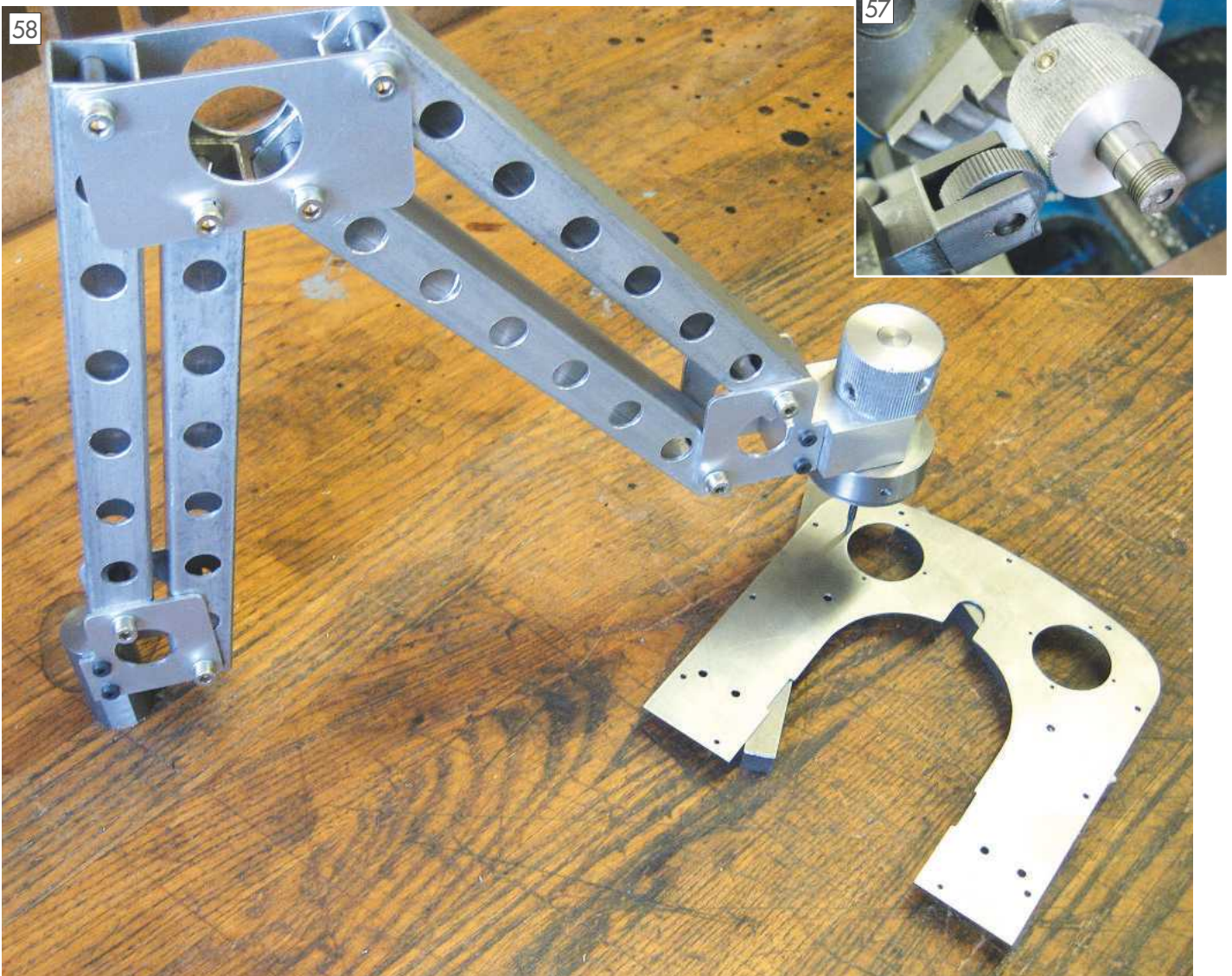


Fig. 15



The 3D Printshow 2015



3D Printing is certainly coming of age,
John Cookson reports back on a dedicated show.

The 3D Printshow in May 2015 was one of the few opportunities to get a good feel for how the over-hyped field is developing and whether it currently offers much to the hobby engineer. In the first show some years ago much of the equipment owed more to Meccano than high tech. Many machines were based on the Reprap principle; that is, machines intended to duplicate themselves. Typically they were built on A-frames using threaded rod and plastic connectors. Many were only available as kits which often had limited accuracy and required frequent attention and even fairly frequent replacement of parts. Some were Friday afternoon designs with obvious problems which made them difficult to complete, not worth completing or unreliable in operation. The big difference now is the complete lack of threaded rods and very few kits. Not surprisingly relatively few of the manufacturers from earlier shows were around for the 2015 show. Ultimaker had a large stand, not surprising in view of their reputation, Printbot were there and several other pioneers. To-day the new machines on show were properly housed in well constructed enclosures with LCD screens to control and monitor the operations. The amateur enthusiast approach of the first show has almost completely gone. The whole domain is more corporate and controlled but consequently lacks the excitement of earlier shows. Another weakness with the current show was the comparative lack of applications apart from some of the obvious biomedical ones (prostheses, teeth, surgical planning).

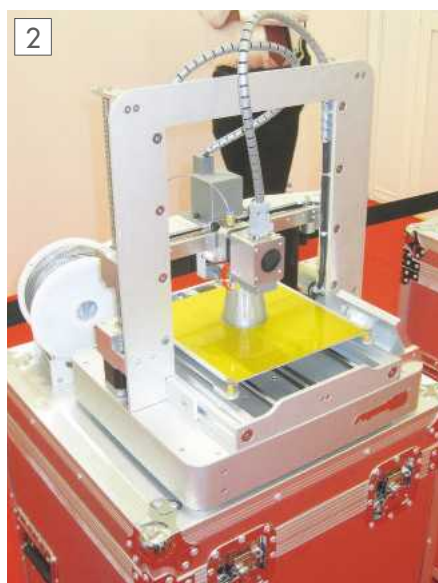


Drone with 3D printed wasp cover.

The most visible application was a 3D printed cover for a micro drone by Kai Bracher in the shape of a giant wasp. The drone, ably demonstrated by Vernon Kerswell of extremefliers.co.uk, was extraordinary, fast agile and capable

(photo 1). Whether the world is ready for six to eight inch long wasps is a bit doubtful. Several adults both male and female found the drone more than a little disturbing. It certainly led one very small boy into screaming hysterics. I loved it. I want one.

The most dramatic change at the show was the quality of the engineering of the hardware. Some of the best engineered machines were on the Rapide stand. These illustrated one of the major advances of the newer kit. In early machines the x axis consisted of two round steel rods with bearings. These were slightly sloppy. The Rapide machines and one or two others had linear rails of rectangular section which gives a much more accurate movement. The Rapide machines were really heavy, solid and substantial, constructed to proper engineering standards with aircraft grade aluminium and wear-resistant bearings. They were not cheap; the least expensive was the 4x4x4 inch build volume version at about £1000 **(photo 2).** The basic design was common to the range with scaling to accommodate different build sizes **(photo 3).** In general the quality of engineering of almost all of the other machines had improved massively over those present in the very first show.



Rapide small 4x4x4 inch build volume printer.



Large volume Rapide printer.

Another notable feature of many of the new machines is the vastly increased build volume. For one in particular, the Big Rep ONE.2, a massive volume of about a one metre cube could be printed (**photo 4**). Aye Aye labs from Poland showed an over-life size model of Paul McCartney and other large scale objects (**photo 5**). This would mean nothing if the quality of the print was not acceptable. Two years ago at an earlier 3d printshow not one of the machines being demonstrated could produce a large volume print without faults, typically separation of the layers. What was incredibly impressive at the most recent show was that all of the machines without exception printed large objects without any flaws. This means that the technology is now very reliable.

The most significant innovation shown was not in the technology of the printers where improvement was evolutionary rather than revolutionary but the technology of the filament that feeds them. Originally there were only two filaments available, PLA and ABS. To use ABS you needed a heated bed. The big issue with both of these filaments was quality. As one who was recently faced with a huge mess when cheap Chinese filament purchased from ebay failed spectacularly I have become particularly sensitive to issues of filament quality. The good news at the show was that a wide range of novel filaments and improvements on traditional filaments was available. The better news was that some of the newer manufacturers were expert in manufacturing filament and similar technology. Verbatim who were once famous as a big maker of floppy discs were offering a range of filaments. In addition to the usual PLA and ABS, they were offering Mitsubishi Chemical's primalloy, a filament with a rubberised feel. Most interesting was a Portuguese firm, Filkemp 3dprintmasterpro, which was into the large scale manufacture of filaments for the weaving industry. If you provide filament for looms which are tens of metres long it has to be reliable because the cost of failure is horrendous. They were looking for a new outlet for their expertise and they were offering a collection of lubricated filaments. Filamentum from the Czech Republic was offering a wide range which included HIPS. This material dissolves in limonene. This means that support can be removed by chemical rather than mechanical means. This is a big deal because removing automatically generated supports in complex structures may be almost impossible. I have a complex model of a partially crushed fossil skull for which I am unable to remove the support without breaking chunks off the model. The avoidance of damage in removing the support is critical and this is a good reason for dual extruder printers. It is a far stronger justification than simply the ability to print in two colours. ESUN from China were offering the usual filaments but also a cleaning filament, a flexible filament, bronze filled filament, wood filled filament and even a conductive one. Fibre force from Italy offered a number of novel filaments including carbon fibre reinforced nylon. One of the less often considered aspects of the filaments is biological safety. A new filament called purement



Big Rep ONE.2 1 metre cube build volume.



HotRod Henry large volume printer with 3D prints.

was shown which contains an antimicrobial and PLA. The problem with fused filament fabrication is that the layering inevitably forms crevices in which bacteria and viruses can thrive. This material has many possible applications particularly in education and catering where the safety of the end-users is of paramount importance.

All in all this was all good news except that many of the materials required a heated bed or very high printing temperature. More materials which do not require a heated bed and high temperatures would be very welcome.

The early 3D printers moved in x,y and z directions in the Cartesian co-ordinate system. A more recent design, the delta configuration was created which moved the hot end by means of three arms attached to three support towers. The printer is basically a robot moving a print head. After a visible surge of interest in Delta type printers two years ago there



Reprap delta printer from a kit.

were some interesting examples at the show. At the top end of the specification scale were the Wasp printers from Italy. These exemplify many of the advantages of the delta design. The head can move with a speed and acceleration not easily matched by the conventional Cartesian printers. For the wasp 20 40 the maximum head speed quoted was 300 mm/s. The print area is 200mm diameter by 400mm height. It can use 1.75 mm filament but has an alternative extruder that can print ceramics, clay and porcelain. In action it was impressive. At the other end of the scale Reprap was offering a small delta printer kit for £199 (plus VAT) which did not have a heated bed but did produce very acceptable quality prints in PLA (**photo 6**).

It would be quite difficult for a model engineer to persuade him/herself that he needed one of the more expensive printers. It becomes much easier if the printer is a multi-function machine. At the show two years ago there were one or two



Shapeways 3D prints.

Zmorph printer output and interchangeable heads.

such machines but now the frontrunner seems to be the Zmorph. The Zmorph printer offers an impressive range of interchangeable printheads, 1.75mm and 3mm extruders, dual head extruder, laser module, ceramics extruder, cake and chocolate extruder and dremel mount (**photo 7**). So a single machine can offer 3d printing and scanning, laser cutting and (light duty) CNC milling. Since it is modular only the modules you require need to be purchased. This is a very powerful approach and very marketable. The actual machine is built on a very rigid frame made of aluminium and the output is more than acceptable.

Of course the way into 3D printing for model engineers need not be through the expensive purchase of a machine, but an expensive use of a printing service. This business is never cheap! The Shapeways stand showed what a highly professional 3D printing service can offer. The most dramatic difference is the range of materials on offer, plastics, silver, steel, bronze, platinum, castable wax and even gold (**photo 8**). The quality of some of the items on display on the Shapeways stand was awesome. Some of these options however require the generation of a wax model first followed by lost wax casting and finishing. Metal sintering is still the province of the major industrial players. If a lesser quality is acceptable there is the possibility of using 3D hubs. These are people who possess 3D printers and are willing to produce prints at a price. This is a movement which has grown massively in the last few years. Between the hubs and Shapeways local 3D print shops are starting to appear. These offer a service of high quality prints for reasonable prices produced to a good professional standard. These are appearing in some surprising places I even have such a shop locally, the 3DPrint House in Southbourne, Bournemouth (usual disclaimer!) Access to 3D printing for model engineers is getting ridiculously easy, what it offers them is more difficult to assess.

The feeling from the 3Dprintshow was largely that 3D printing was becoming a

mature technology. There was a printer, however, doing its best to subvert that view. Mcor technologies offer a paper based 3D printer using ordinary office paper. It is based on paper, water-based adhesive and water-based ink and provides true colour 3D prints with low running costs. Its resolution was quoted as 12 x 12 x 100 microns. How would the paper perform? A 3D printed chain of approx. 2 inch links with rectangular, rounded edges proved impossible for me to break. Paper is an incredible material for production of durable items, Victorian lacquered papier mâché items such as trays are still in excellent condition after over 100 years. The snag is that the machine is about the size of a large American fridge and costs about 34,000 euros (**photo 9**). The important thing about this machine is that it shows that novel and interesting ways of producing 3D prints can be still be invented. The

technology can still go in exciting new directions. The output in full colour is amazing (**photo 10**).

So what exactly did the 3D printshow offer to model engineers? Firstly, the available technology is still too far from providing the resolution engineering requires. Secondly, some of the materials are not durable enough nor heat resistant enough for many ME applications. Thirdly, the cost is hard to justify in pure model engineering terms. The applications in model engineering have so far been largely limited to preparing patterns for castings. Unless you are excited by its other applications spending over £1,000 for a printer with very limited applicability to ME would seem perverse. 3D printers are however great fun, and, of course the technology, materials and accuracy are increasing all the time. We may yet see the lathe and milling machine as optional extras to the model engineer with his 3D printer. ■



Mcor printer.



Mcor true colour 3D prints.

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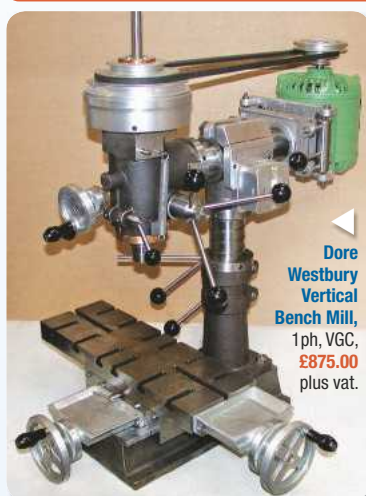
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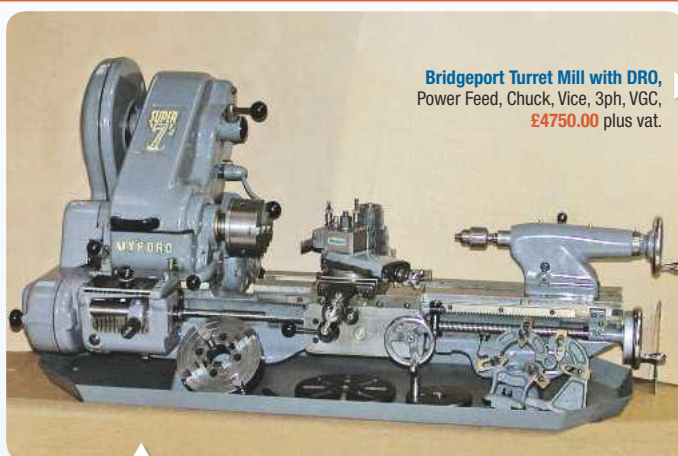
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A bit of history

Back in the 1970s I was looking for a horizontal milling machine to augment my workshop. Not long before, I had acquired an old Myford ML7, used previously mainly in the construction of clocks. Therefore, there was little apparent wear from cast iron dust, steel swarf etc. It was covered in what looked like shellac, so I decided to dismantle, clean, and check it for wear – of which there was very little. It was repainted and reassembled.

The Trident C Milling Machine, which I found for £50 was in a sorry state. Recently I found that mine of information, www.lathes.co.uk Looking under Pallas Millers, Model C Miller, I discovered that the Model C was manufactured from the late 1920s and was originally flat belt driven and with rack and pinion feeds on all three axes. There were screw feeds on the cross and vertical travels. By the time I bought it, the rack and pinions had been removed, and a screw feed had been applied to the knee slide, but annoyingly with a left hand thread. A previous owner had converted it to V belt drive with a motor bracket and lay shaft on hefty angle iron frames on the left hand side of the machine. The photograph, top right, shows it after the initial improvements but before the current refurbishment was started.

The Miller's Tale

In the latest of our sequence of articles on restoring vintage milling machines, the Revd. Ian Strickland recounts the story of the magnificent Trident Mill he brought to the 2014 Model Engineer Exhibition.



Another search of *Model Engineer* produced an article about changing ML Super 7 pulleys to poly-Vs. This article gave all the crucial dimensions for PJ belts, and pulley grooves, except that I reckon the depth of the V should be 0.090 and not 0.070 inch as shown (**ref 8**). I was able to check this, as in the 'spares box' I had a pulley and a belt from a washing machine of the same PJ cross section.

Once the two pulleys had been machined and temporarily fitted to their shafts, measurements around each pair of pulleys gave different belt lengths for three pairs, but the same for two. More time for thought. It transpired that where the belt lengths were the same, the pulley diameters when added together were the same. Back to the spreadsheet. By keeping the ratios the same, the diameters of the other pairs of pulleys were adjusted till the sum of the diameters was the same. Another lesson learnt. However, in this instance, I was able to obtain a belt of the average length, as there was enough adjustment to accommodate for the 'wrong' pulley diameters. This adjustment is clearly visible in photo 2 the belt being finger tightened using the two bolts to the left of the idler shaft assembly.

The finished mandrel pulley is shown in **photo 35** complete with a back gear wheel, and detent ring for the back gear lock. **Photograph 36** shows the dividing head in use for milling the 15 slots in the detent ring. **Photograph 37** shows the Myford style sliding bull wheel lock, which contrary to the ML7, is locked by moving



Trident C horizontal mill.

the detent outwards into one of the slots in the detent ring. Access to the bolt head was really tight, so a cut away (**photo 38**) adjacent to the back of the front bearing was ground out to enable a thinned down ring spanner access to the bolt.

Photograph 39 shows how tight this is.

Next, to work on the washing machine pulley mentioned above. It was about 10.5 inches in diameter so this would be pressed into service as the large pulley, driving the idler shaft, while a new motor pulley was cast in zinc. The washing machine pulley was mated to the major part of the large pulley driven by the motor. This required cutting the spokes off the washing machine pulley close to the rim, as the spokes were steeply inclined and the hub was too small to fit the idler shaft. **Photograph 40** shows drilling and tapping the washing machine pulley to the large idler pulley. **Photograph 41** shows a temporary set-up of the milling machine to trepan off the outer V groove. Once the washing machine pulley was bolted to the hub of the old Picador pulley it was very evident that it was not circular, and that the poly-V grooves were drunken. Both had to be skimmed. The back gear had to be temporarily reinstated to use one of the slowest speeds. The poly-Vs had to be machined by manually turning the big



Finished mandrel pulley with access to bull wheel grub screws and oil hole with grub screw to retain oil.



36 Machining detent slots for mandrel pulley back gear lock.



37 Myford style bull wheel lock.



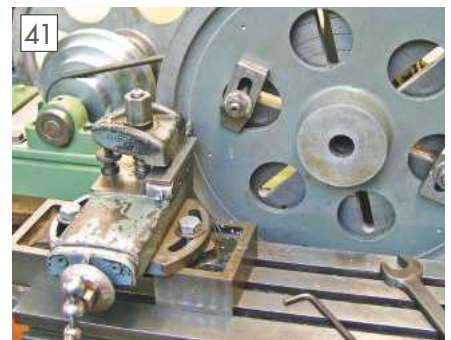
38 Cut away to allow access to bull wheel locking bolt.



39 Cut away to allow access to bull wheel locking bolt.



40 Old washing machine pulley being fixed to old single V pulley.



41 Temporary mill setup to trepan large pulley to remove large V pulley.



42 Skimming outside of multi V pulley.



43 Skimming pulley grooves.

pulley round, as severe chatter (a high pitched shriek) occurred under power (**photo 42**). The DIY belt guard was put in place to stop swarf getting into the grooves of the new belt (**photo 43**).

Final reassembly was now in sight, but preparation and painting had to be completed first. Previous repainting of

tools was done with Humbrol Grey Enamel, but what the workshop needed was a less depressing colour. I rather like the 'muddy green' of some modern machine tools. Humbrol no longer supply the larger tins of enamel, so a search of the Internet led me to Craftmaster and Narrowboat Paints (**ref. 9**). The colour chosen was Channel Green,

which is available as an engine enamel, so pretty resistant to oil etc. The smallest size can is 1 litre. The joy is that no undercoat is needed, but two or three coats give a good finish. Not being a cellulose, touching up is easy.

Reassembly followed. Having used a low trolley with castoring wheels to move the



Reassembled but awaiting a new belt guard.



Reassembled and repainted.



View looking at knee and underside of the table.



After refurbishment.



After refurbishment with tool table.

mill around while working on it, the increased height meant less bending over to use it. So a plinth 6 inches high was made up from an old pallet (**photo 47**). The mill is not quite as stable as when sitting on the concrete floor, so a stout angle iron stay was bolted to the rear of the foot casting which also helps support the overhanging weight of the motor and the brackets, which were added historically, to the left hand side of the machine. Levelling screws were fitted. Those to the foot required threaded brass bushes inserting from beneath to accommodate the $\frac{5}{8}$ inch BSW bolts. Locking nuts were added on top.

Time for finishing the painting, preceded by much rubbing down and grinding or filing away unevenness left over from the original casting process. **Photographs 44 to 48** show the transformation, and **photo 49** shows how sad it looked before.

Having reassembled the mill, a precautionary check for squareness of the three axes was made. To my disappointment the X-axis of the knee, which was spot on previously, was now about 0.003 out in 4 inches with respect to the front face of the column in the horizontal plane. The knee was removed and paint which had run over the mating surfaces was removed, but this still left an error of about 0.002 in 4 inches. Clearly this needed investigating, but for the time being it was decided to use the mill, to 'run it in' somewhat, while making a 4 inch capacity fixed steady for the ML7 in preparation for making a vertical head for the milling machine. This head is to be used initially to bore out the bearing holes and the overarm holes in the main column. The

idea is to temporarily mount the new milling head horizontally on the table, and with a suitable boring bar to bore out the various holes. The drive for the head being taken from the lathe via a temporary set-up using the long motor belt, which previously powered the milling machine.

The idea for the proposed vertical milling head was found in *Model Engineer* back in 1984 by J.M.Wilson (**ref. 10**). The drawback of his design is that there is no vertical feed which I would like to include in my adaptation. Two inches of vertical feed should do it. This, our Editor permitting, will be the subject of a future article.

One other addition made, was to provide a worktop to the left hand side of the drip

tray, as there is never enough space to put things on. The supports were made from old bed angle and bolted in between the base column and the drip tray (**photo 47**). Two lengths of pine were screwed more or less at right angles to support the worktop, which is a left over top from a washing machine. Photograph 48 shows the worktop in place abutting an oak work surface in front of the lathe, which is at right angles to the left of the mill. The mass bolted to the end of the overarm is a large lead casting to add mass and reduce chatter while milling.

I hope this has inspired some of you, and I think you will agree that the Trident mill has got its old self respect back! ■

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Plastic Fantastic

Dear Neil, I was pleased to read that Doug Melrose was machining Delrin (acetal), it is a good material for very fast cool cutting, is an electrical insulator, easily takes a fine finish and needs no cutting fluid. However, there are drawbacks for the home machinist. It has a low elastic modulus so deflects or compresses under load relatively easily, has a very low coefficient of friction (slippery) which is a good thing for bearing material but here comes the warning - whilst turning overhanging in the chuck, cutting force can easily cause the material to slide in the jaws, the tool to dig in and the workpiece to pop right out at speed bounce of your skull and end up in the far recesses of the shop. What I do is to glue back-to-back two strips of 800 wet-and-dry abrasive paper, wrap this round the acetal workpiece and grip firmly in the chuck. Light fast turning can then commence with confidence. Unless they slip the chuck jaws will suffer no damage from the very fine abrasive.

Hard rubber also has a very low modulus so can pop out very easily unless so fixed. Don a face mask then turning can be achieved with a scriber clamped in the toolpost at an acute angle, using soapy water as a cutting fluid, fed for a short distance followed by parting-off or facing at an obtuse angle. Wipe dry the lathe and re-oil. Bores are best done by hand with a cork borer such as those which were used in chemical labs for piercing corks and rubber bungs.

Peter Peters, Sherborne, Dorset

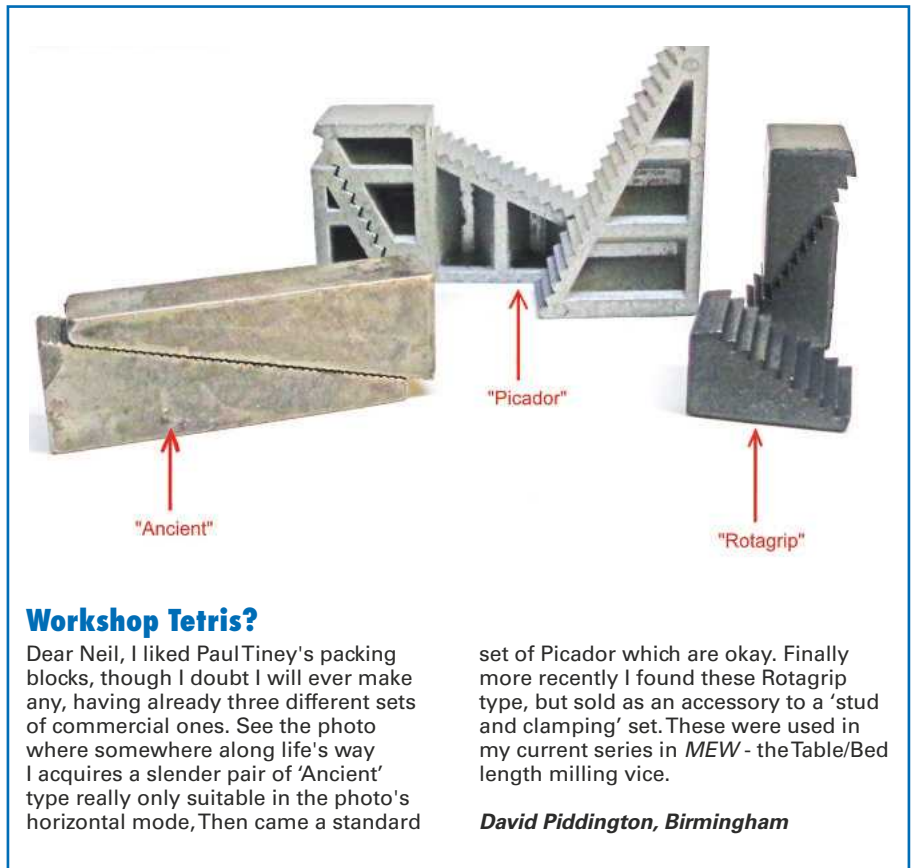
Metric Translation

Dear Neil, I am a retired engineer trying to be a model engineer which does not work very well because I still expect everything to be made in double quick time, but on the subject of conversion between metric and imperial measurements the best way to achieve this is with a £2.50 calculator which will fit in your pocket no trouble.

To convert any imperial measurement to metric put in your imperial figure i.e. 3.375 then multiply by 25.4 which will give you 85.725mm. To convert metric measurements to imperial put in your metric figure i.e. 26.5mm then divide by 25.4 which will give you 1.0433 inch.

This is by far the most accurate and easy method.

Tony Pardoe, Great Witley



Workshop Tetris?

Dear Neil, I liked PaulTiney's packing blocks, though I doubt I will ever make any, having already three different sets of commercial ones. See the photo where somewhere along life's way I acquires a slender pair of 'Ancient' type really only suitable in the photo's horizontal mode, Then came a standard

set of Picador which are okay. Finally more recently I found these Rotagrip type, but sold as an accessory to a 'stud and clamping' set. These were used in my current series in *MEW* - the Table/Bed length milling vice.

David Piddington, Birmingham

Level Pegging

Dear Neil, whilst perusing the 25 year special issue, and what a good read it is, I came across the Engineer's Level on page 66. Having made one very similar as a press tool apprentice at the Ford Motor Company's training school at Dagenham Dock in the late sixties/early seventies it caught my attention. We had to machine it from a solid lump of steel as a shaping, milling machine, heat treatment and surface grinding exercise. Having retrieved my one and measuring it I find it is of similar dimensions albeit mine is a tad longer at 6 inches. We had to make all manner of equipment for our own engineered toolbox, drill blocks, centre finders, angle plates etc all designed to test our skills. I always assumed these items were designed by our instructors.

Many thanks for a smashing publication.

Gary Chambers, by email.

P.S. A tad was a considerable amount larger than a gnat's...

Go Digital!

Dear Neil, I have to confess that I am useless with computers and admit to being a little intimidated by them. However, as I missed the first dozen or so issues of *MEW* in the early nineties, I decided a couple of years ago to subscribe to digital issues as well as the printed versions. This gave me easy access to the magazines I don't have.

The real purpose of my Email is to encourage anyone who has recently started taking *MEW* if they can afford it to consider adding the digital facility as well. Our magazine is awash with information largely unavailable elsewhere. Pages of interest can be printed out to take into the workshop, as I recently did with Mr Unwin's article in issue 7 concerning a very small drill sharpening jig which works beautifully, or his automatic boring and facing head that I made some time ago from an article in issue 2 or 3. So take the plunge, you won't regret it.

John Crammond, Cumbria.

Vice Tweak

Dear Neil, in his article, David Piddington says that whilst his vice will release the pressure on piece of work, it will not retract/release it! That is easily and simply done - just lengthen the two jaw guide bars, and in that length add a pair of compression springs!

They will ensure that as the vice screw pressure is eased, so the moving jaw will follow and release the workpiece.

David Hockin, Portishead.



Swarf Tray

Dear Neil, I have recently received the June issue of *MEW* and have seen the reader's tip for a Swarf tray, awarded 'Tip of the Month'. I am afraid it has several faults for the following reasons:

1. It is made from metal with some sharp corners so there is a chance of cutting oneself.
2. It is fastened to the cross slide so under some conditions the lead screw is not covered.
3. It provides little or no protection when mounting a heavy object to the chuck/back plate.

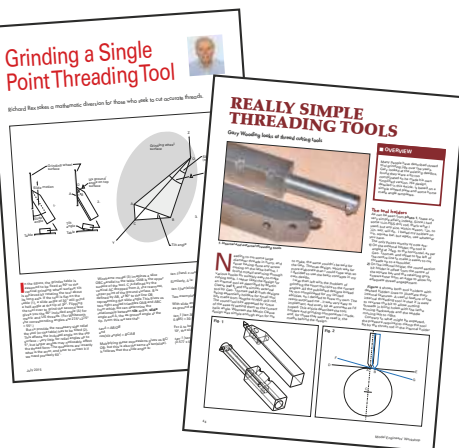
A better and correct solution is to make the lathe bed cover from 3mm leather and fasten it to the main longitudinal slide. The side where it is fastened with one screw is fastened between two pieces of stainless steel sheet, such that

it protrudes slightly on the right hand side so that it forms a seal for the cross slide.

I have had three Myford Super 7 lathes, the first being in 1957 and the third in 1988, which I still have and use almost every day. The two previous lathes also fitted with similar leather protection are here in Switzerland and in use almost every day as well, without problems.

Philip T. Bellamy

To be fair, I think that this solution is a different, rather than a better one. With Geoff Walker's original design it was possible to lift the tray off and empty swarf into the bin with ease, and the aluminium sheet is easy to finish so that there is no risk of cutting oneself – Ed.



Threading Tool Geometry

Dear Neil, I have been a subscriber to *MEW* for a while now and I am concerned about a recent article produced by yourselves. The recent issue of July 2015 no.230 has an article by Mr Richard Rex on the Grinding of a Single Point Threading Tool. In Jan 2010 No.159, there was an article of substantially more detail and calculations by a Mr Gary Wooding titled Really Simple Threading Tools. Gary Wooding gives details and drawings of both the point grinding and the tool holders that is required to complete the process.

Stephen Reeks, by email



Workshop in a Can

Dear Neil, I was intrigued by the above article and noticed the cabinet with the combination lock. This seems to be a standard 'Mark IV Manifold' lock. If Bob Reeve or his friend cannot get into the cabinet (and would like to) he might like to know that it's possible that the lock has been set to the standard setting which is applied when no longer in use. This is 40-50-60 followed by a number which depends on the orientation of the bolt which secures the door.

Trevor Hills, by email

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Power Hacksaw



Metal cutting bandsaws have become relatively inexpensive, but Stan Nesbitt believes his home-made power hacksaw is still a practical alternative.



Stan's shop-made power hacksaw with the guards removed.

Design considerations

This type of reciprocating power hacksaw (**photo 1**) usually employs a dovetail type sliding arrangement to translate rotary action into a cutting motion. Because I intended to prefabricate this machine I opted for two sets of Phosphor Bronze bushes sliding on two round 5/8 inch mild steel bars.

This system has proven very satisfactory for many years and only needs a few drops of oil on the bars during operations. Motive power is a 1/4 hp electric motor which is the single speed fully enclosed type. As these motors rotate at 1425 rpm, two step down stages were required to achieve an acceptable cutting speed. All the material and parts used were from my scrap box, except for the toggle switch and the new 14 inch machine hacksaw blade. I should say that I had bought an auction lot of redundant linen machinery which included several bushes, gears and castors etc., all for £5.

Commercial examples of these machines are normally very heavy with lots of 'meaty' castings. With this in mind

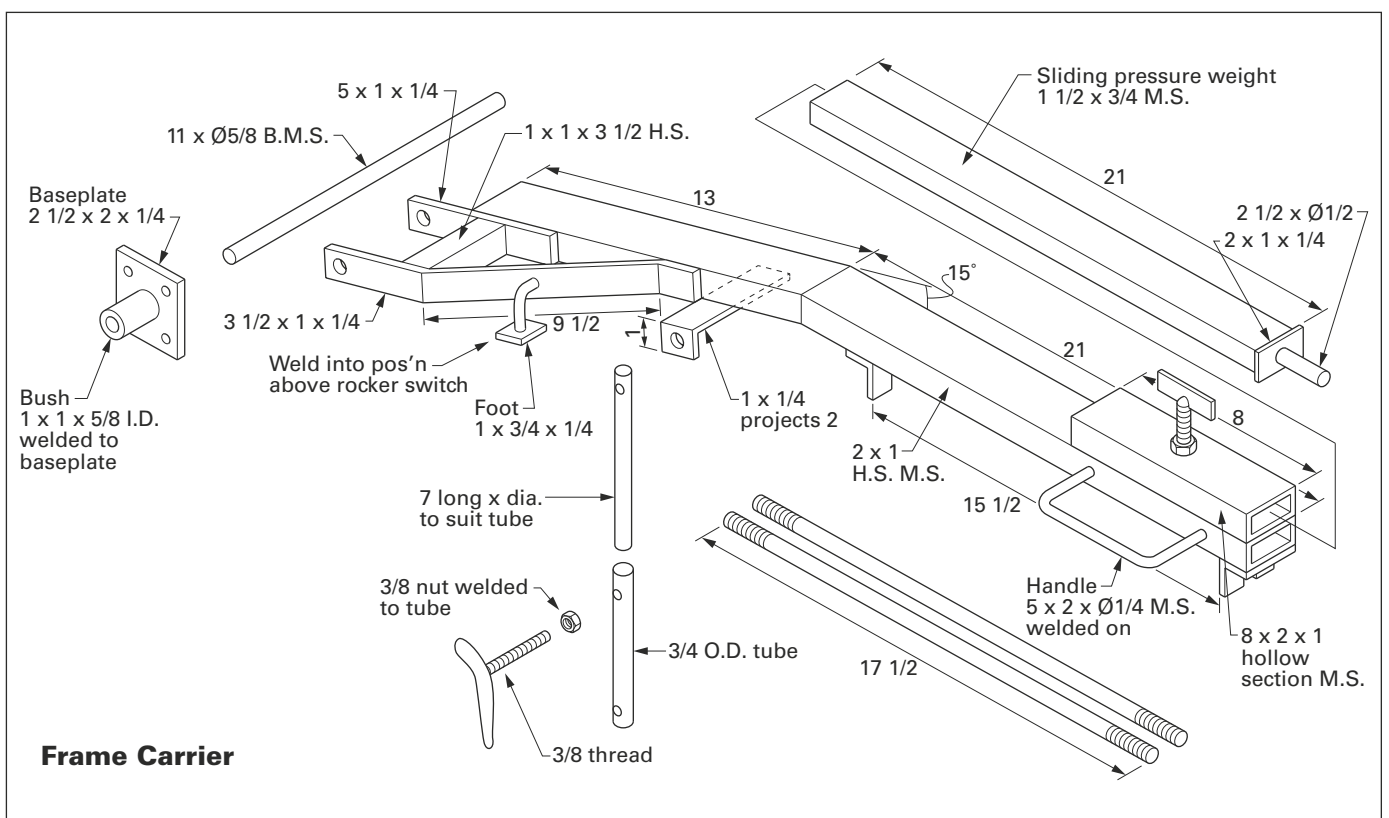
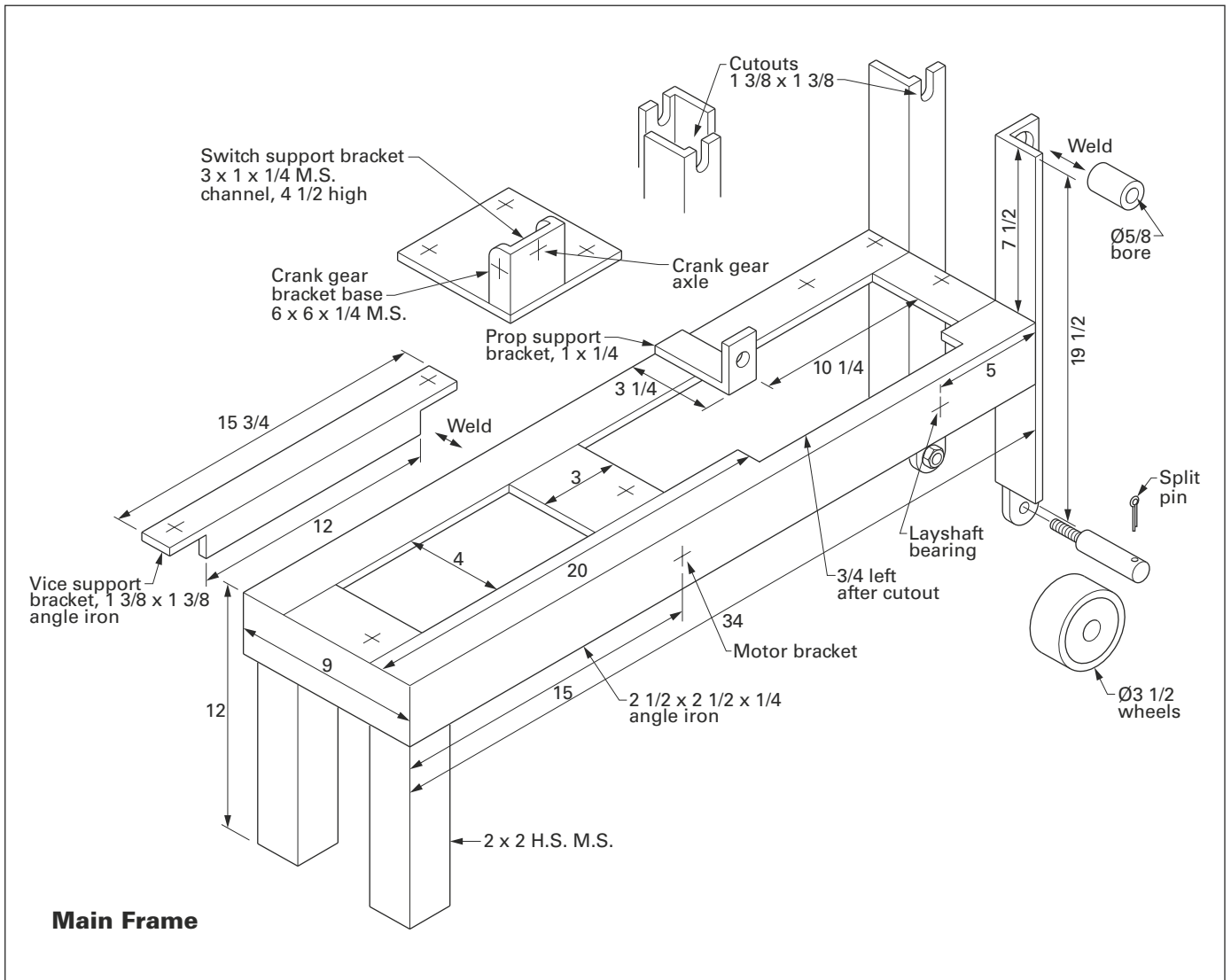
I did my best to use heavy gauge sections as far as possible to ensure the necessary stiffness. I made this machine as I needed to cut 4 inch black pipe and other heavy wall tubing so the vice is capable of holding these relatively large sizes. There is provision for angle cuts but I tend to avoid disturbing the accurate 90 degree setting, if at all possible. The drop arm pivot bearing incorporates extra space to allow adjustment in both planes (**photo 2**). The vice can also be finely adjusted. Some of the heavier cuts require some minutes to complete hence the essential cut off switch to allow attention to other jobs as cutting proceeds. Indeed this machine can cut as fast you can drag out and measure up for the subsequent pieces.



The drop arm pivot and drive arrangements.

Roller trestles are included as proper support at both sides is essential when handling full lengths. Careful height setting of the trestles is important to allow for uneven surfaces and particular attention to the correct seating of the job in the vice, to ensure an accurate 90 degree cut both horizontally and vertically.

The machine incorporates casters to facilitate positioning and storage (**photo 3**). It can be moved sack truck fashion with the drop arm locked but this still requires some effort.





The saw from the same angle with guards fitted.



The saw also has an effective guard over the drive belt.



Another view of the saw tilted up, showing the sizable motor.

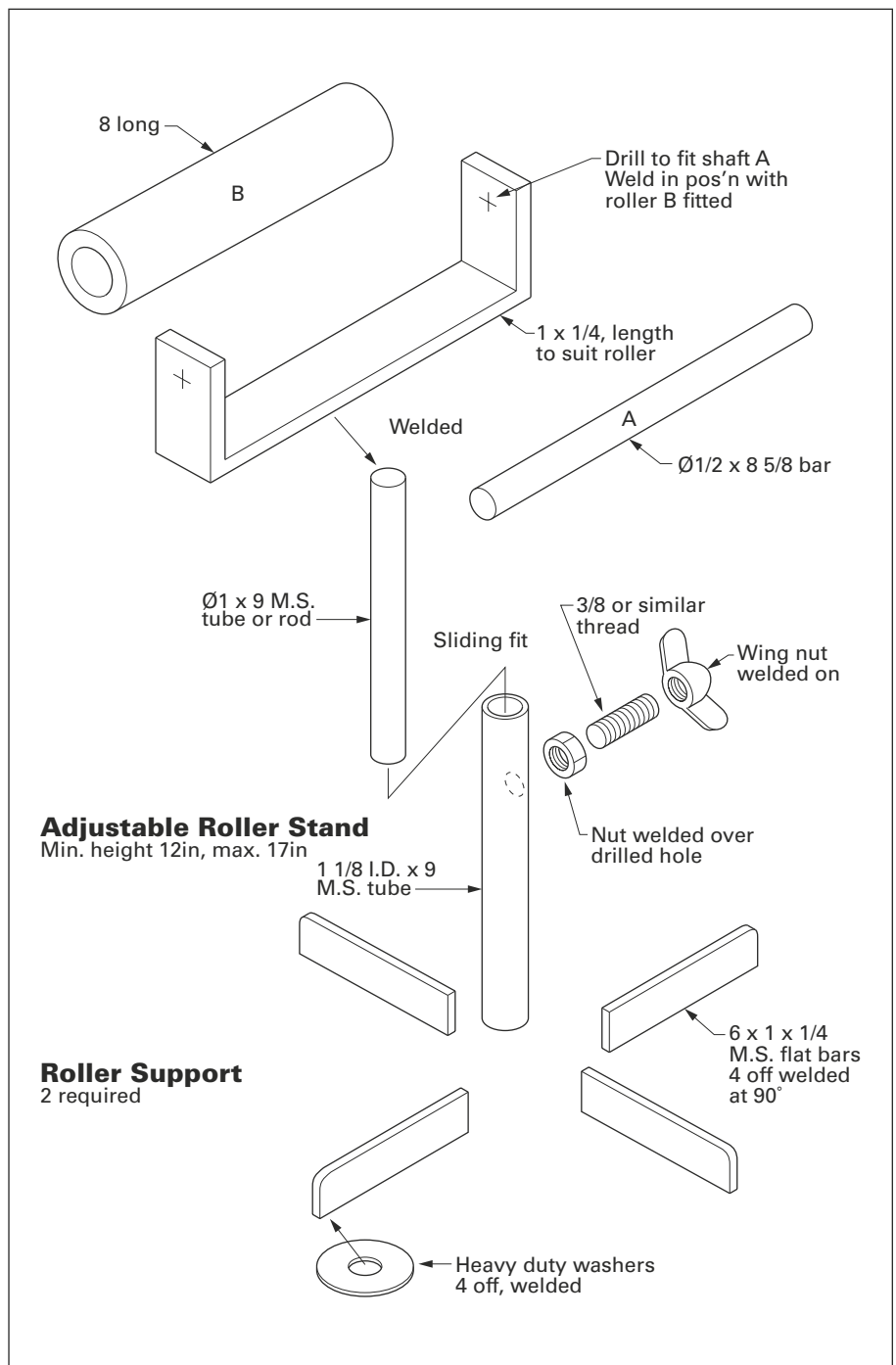
on what you have available are of course acceptable but always err on the heavy side to provide the necessary stiffness.

Fully enclosed electric motors such as I have used (**photo 6**), may need to be obtained from an electrical supplier as the modern open cage multi-speed and reversible types would not be suitable. These motors are normally mounted on shock absorbing brackets but for this application I welded brackets directly onto the motor body as part of the motor cradle. Tensioning the V belt is achieved by simply rotating the cradle and tightening all three retaining bolts.

The 72 tooth gear which I used was already drilled and fitted with a special bolt for a crank which I was glad to utilize.

Exploded view drawings accompanying this article are intended to show individual parts which make up each component. Of course, alternative methods or materials will also suffice. I opted for T-section mild steel for the blade holder as it facilitated the blade being secured more centrally at the back and for tensioning at the front end. T-section also provides adequate stiffness which is essential for accurate cutting.

Steel tubing, free to rotate over a welded in round bar, acts as an effective roller on the adjustable trestles, at very little cost.



You will notice that the roller frame ends protrude above the roller to prevent heavy pieces sliding off.

All the above suggestions are assuming that an Arc Welder is available to you. I bought my first Gamages Arc Welder in 1968 and although it was very basic, I managed much useful work with it and have never been without a welder since then.

Method of Operation

The drop arm may be elevated slightly above the thickness of the piece to be cut and locked in this position using the adjustable support. The two roller trestles may be positioned with the height roughly set. Using a hacksaw or file make a slight cut just outside of the marked line on the rear corner or area to ensure that the machine blade will have a 'bite' to start in the position required.

Locate the material in the vice and ensure that it is properly seated on the floor of the vice. Minor height adjustment of the supporting roller trestles may be required. Position the material cut mark under the blade and lower the drop arm into the starting position. Tighten the vice jaw firmly and ensure that the drop arm support is loosened. Slide out the counter weight according to the pressure required for the type of material being cut. Ensure that nothing will foul the cutting movement and press the toggle switch to start. As cutting proceeds ensure that the vice remains firmly holding the material.

7



Another view of the completed machine.

The cutting time will allow you to drag out and measure subsequent pieces.

The machine may be stopped in an emergency by pressing down on the toggle switch under the cut off tab (*builders may prefer to fit a no-voltage release switch – Ed.*). All being in order the machine will stop automatically and the cut piece will rest on the machine frame and outer trestle. When cutting very short pieces or trimming, the cut

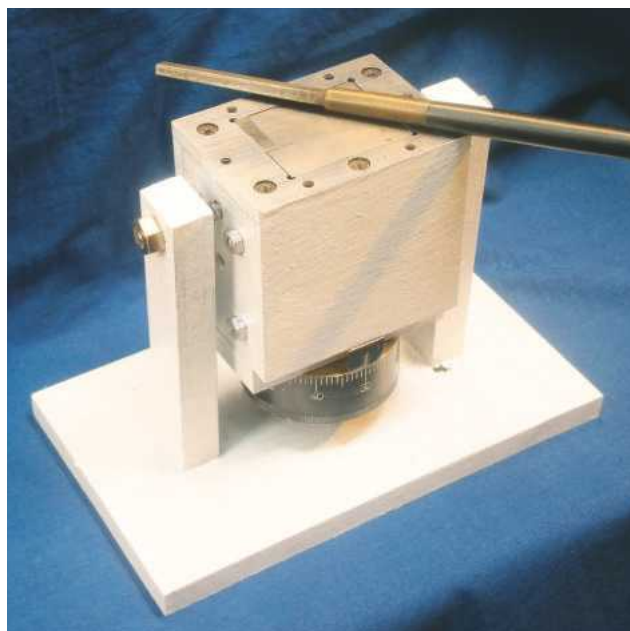
should be supported with a screwdriver until complete and the piece allowed to fall to the floor. Remember that such small pieces may be hot as they come off the machine.

You will probably not finish this project (**photo 7**) in one weekend but if you do manage to complete one, it will save you many hours of labour and prove to be a tireless companion in your workshop for a lifetime. ■

In our Next Issue

Coming up in issue 233

On Sale 11th September 2015



A rare aid to filing, Bill Morris describes a swing tool.

The return of CNC in the Home Workshop sees Marcus Bowman making a pair of motorcycle heel guards.



Mark Noel continues our theme of mill modification and restoration by detailing improvements to his Myford VMB.

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Test Flying The EMG-12



Jason Ballamy makes an independent assessment of the EMG-12 Endmill Resharpener Module.

Those who regularly follow the forum will have noticed the thread (**ref. 1**) that has been running over the last few weeks about the new milling cutter sharpening module that ARC Eurotrade have recently started selling. I raised a few queries in the thread and was contacted by Ketan from ARC to see if I would like to borrow their demo model and comment on my findings, to which I said yes.



The next day a very robust ply and honeycomb cardboard box arrived which contained the module, transformer for the DC motor, case with the various holders & cams, there was even a paintbrush to clean up afterwards. Additionally the disc for HSS cutters was sent (one for carbide is fitted as standard).

The instructions are in clear plain English and easy to follow but that may be more to do with the ease of using the machine, I only looked at the instructions while doing the first cutter and a quick glance the first time I did a 2-flute one just to check I had the holder the right way round.

I tend to use a large proportion of imperial cutters so as the module only comes with metric holders I quickly knocked up 3 new holders to take 1/4, 3/8 and

1/2 inch cutters from 20mm MS bar. A short length of 20mm plastic conduit allowed me to connect a vacuum to remove the waste.

How it works

I won't go into how the machine is used as that was covered in John Stevenson's review in *MEW* and can also be found on ARC's site (**ref. 2**). I will detail below a few different cutters that I sharpened and in most cases show a before and after photo of the cutter and a sample cut again both before and after, one looking at approx 45° and the other from above. All cuts were 1.5mm deep and cutter speed was my usual what sounded right, feed about 6 inches per minute by hand. Material was an inch-wide piece of mild steel.

Cutter 1

This is a 6mm HSS 3 flute cutter by Hertel and would be classed as an FC-3 disposable, it was good to find that these quite short cutters can be held easily.

Photographs 1a and **1b** show the cutter before and after sharpening, **photo 1c** shows the finish left by the mill before and after sharpening.

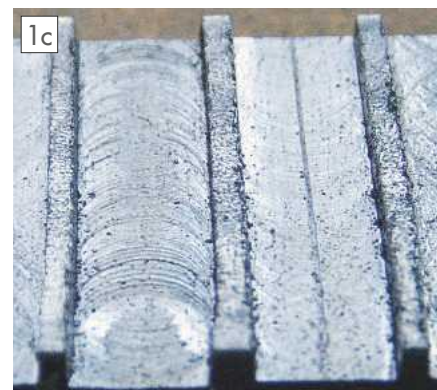
It's quite easy to see that the finish to the bottom is a lot better and consistent after sharpening. Also worth noting on the before cut is how the cutter was being deflected to the right and as it exited the test piece (nearest viewer) straightened up which is why the side seems to deviate to the left no doubt caused by the additional force required to push the blunt cutter



Cutter 1 blunt.



Cutter 1 sharpened.



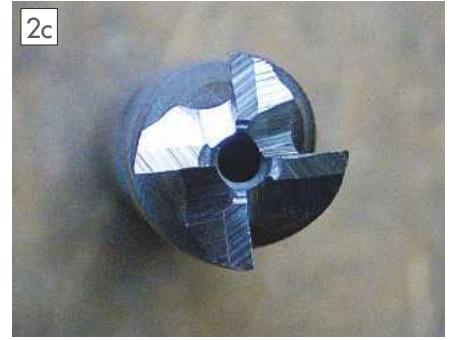
Cutter 1 performance before (left) and after.



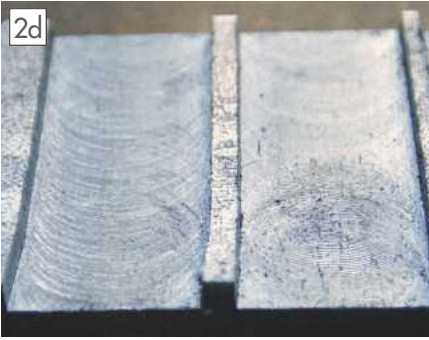
Cutter 2 blunt.



Cutter 2 after first sharpen...



...and after a second to remove blunt edges.



Cutter 2 performance before (left) and after.



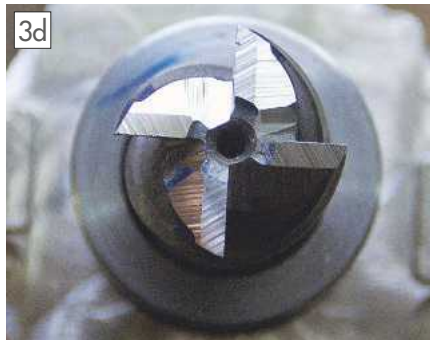
Cutter 3 blunt.



After primary sharpen.



After secondary cut.



After gashing.

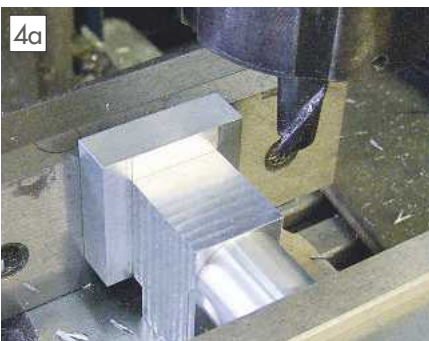


Cutter 3 results before and after sharpening.

through the metal. I think the line down the middle of the after cut is where I returned the mill to the starting position without raising the bit and the stationary cutter marked the finish.

Cutter 2

A relatively cheap HSS 4-flute 10mm cutter from Hong Kong by Richon. Before (**photo 2a**), the yellow lines show the extent of the easily visible heavy wear. After sharpening (**photo 2b**), the machine only removes approx 0.4mm from the length so as you can see there is still a blunt area along the side of the flute.



Cutter 4 blunt.



After sharpening...



...and end on after sharpening.

I quickly reset the cutter in the holder and ran it through the sharpening sequence again which removed all the heavy wear from the edges and left the tips like this (**photo 2c**). Also worth noting are the striations from the grinding on the existing surfaces.

Before and after cuts were much the same as cutter 1 with a better finish and the cut felt easier as it was hand fed through the test piece, (**photo 2d**).

Cutter 3

Another Richon one, this time 1/2 inch 4-flute HSS - blunt in **photo 3A**. I blued

the end with a marker to make things easier to see, **photo 3b** is after the primary cut, then the secondary (**photo 3c**), and the gash cut to complete (**photo 3d**). I got similar results to the others with an improvement to the finish (**photo 3e**).

Cutter 4

This was a 3/16 inch HSS 3-flute Hertel FC-3 cutter. **Photograph 4a** is before and **photos 4b** and **4c** are after sharpening. This time I had a virtually new cutter so did a cut with that on the left, the blunt one before sharpening in the middle



Comparison of (left to right) new, blunt and sharpened cutters.

and after sharpening right, similar improvements again (**photo 4d**).

Cutter 5

This is a 12mm 2-flute HSS cutter that I had been given to try. I had not done much with it before I managed to drop it while removing from the ER collet and as is the way I also did not have my usual bit of MDF on the mill table which resulted in chipping both corners off. As there was still a lot of life in the edges I just freehand ground it back to get rid of the damage, **photo 5a** shows it cutting some 6082 about 7mm of the side being used and 0.100 inches per pass, not too bad which shows it's not so much the end as the side which does the work on a cut like this though it would be useless for plunge cutting.

I ground away all my sharpening efforts and then sharpened on the EMG (**photo 5b**). This was the easiest cut to make across the test piece, again maybe having more to do with the barely used edge than how the end was ground (**photo 5c**).

Cutter 6

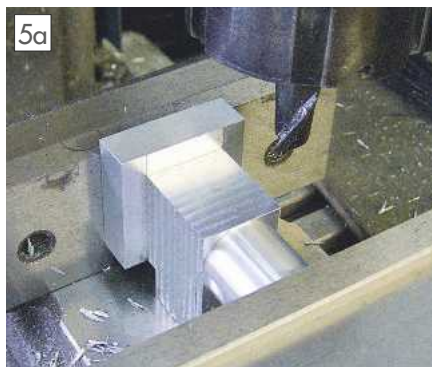
This is just to show how, if the sides are badly worn, you can grind all the damage away to leave a cutter looking like **photo 6a**. And it takes hardly any more time to completely shape it than it does just to touch one up (**photo 6b**).

The only thing to watch is that you get your freehand grinding reasonably square across the end as with only 0.4mm being removed it may need a second pass to get all 4 corners sharp. I marked this one and checked after the primary & secondary grind and could see what had been missed so quickly reset it in the holder and started again (**photo 6c**).

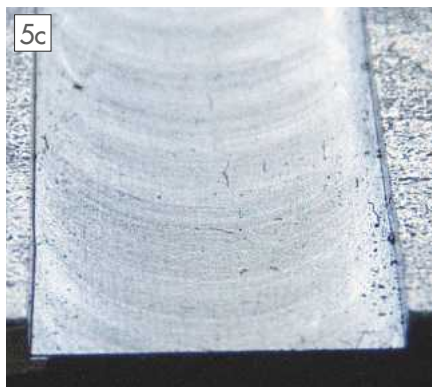
Finally for those that are curious **photo 7** shows the profile of the grinding disc.

Conclusion

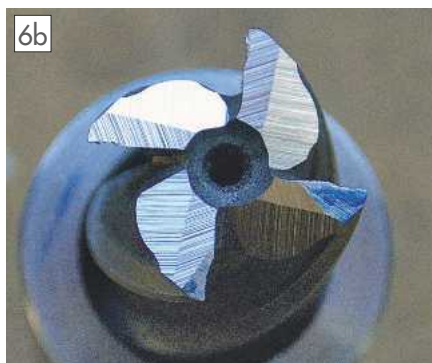
Despite its looks, this is a robust and well made machine and makes sharpening cutters a very simple, easy and quick job. Like any sharpening that only cuts the end the final cutting edge will only be as good as the edge that remains on the cutter but



Cutter salvaged by grinding across at an angle.



Test of the resharpened cutter.



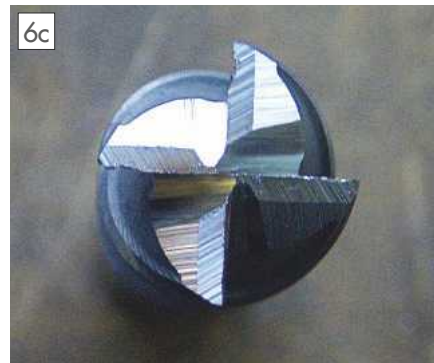
First grind – not enough material removed.



Cutter resharpened on the EMG-12.



Badly blunted cutter ground flat.



After a second sharpening.



The profile of the EMG-12 grinding wheel.

even if there is heavy wear or damage to quite a bit of the cutter it's not too much trouble to rough grind back to an unused edge and do the ends.

I think that if you owned one of these grinders you would tend to sharpen on a regular basis before any heavy wear took place, which is much how they were being used when John first saw them in China. It takes less than two minutes to set a cutter in the holder, sharpen and remove from the holder so I think users would not mind that and soon get into the habit, if similar cutters are grouped together you can get through sharpening them very quickly. I spent about 3 hours one evening and including stopping to take photos and do the test cuts managed to sharpen about 40 cutters, only one could not be done and that was a $\frac{7}{16}$ inch dia on a $\frac{3}{8}$ inch shank, if you had a lot of cutters like this a custom holder could soon be made.

If I got through more cutters in a year than I currently do I would definitely be thinking of getting one of these but will pass at the moment as it would take a long time for me to spend that much on cutters. ■

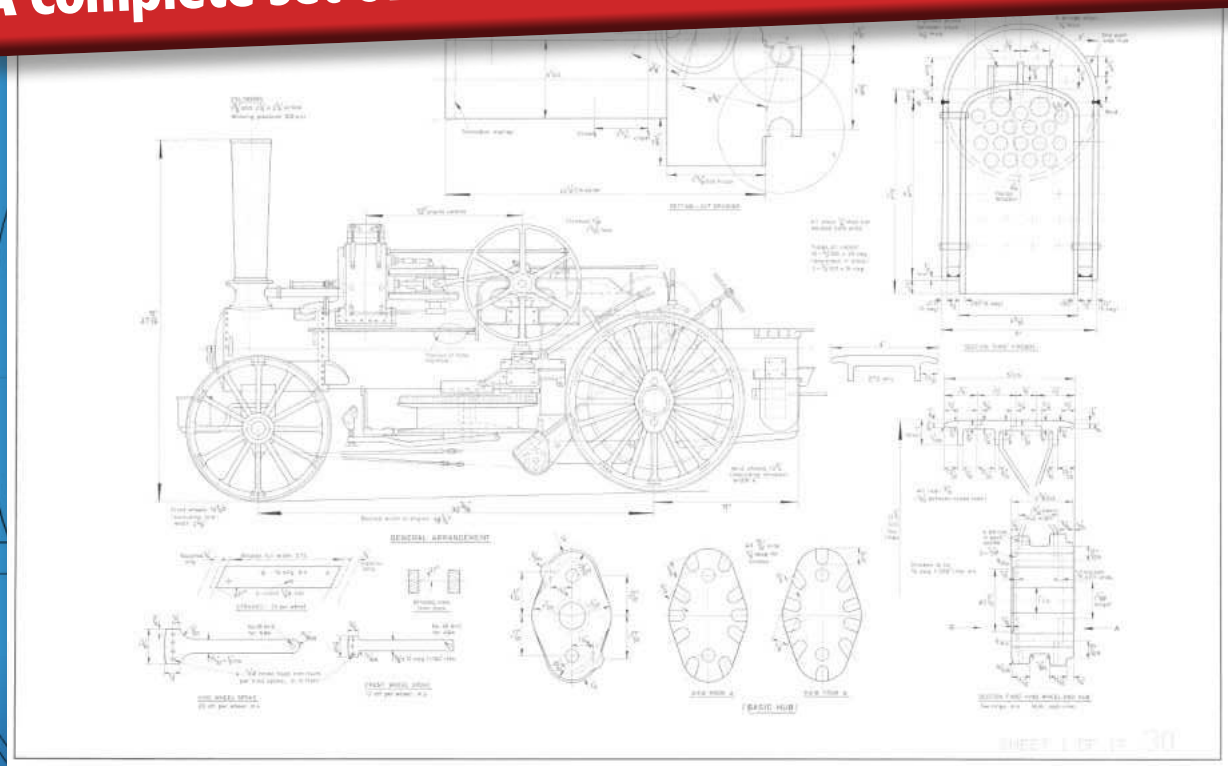
REFERENCES

1. <http://www.model-engineer.co.uk/forums/postings.asp?th=106060>
 2. <http://www.arceurotrade.co.uk/reviews/MEW228-EMG-12-Review.pdf>
- The EMG-12 is available from ARC Eurotrade and currently sells for £850.00
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An Improved Depth Index for a Drilling Machine



Peter Shaw offers a simple and effective solution to giving a basic pillar drill a usable depth readout.

This project (**photo 1**) grew out of a need to be able to drill with reasonable accuracy, some 4mm diameter holes to a depth of 2mm including the cone at the tip of the drill. These holes were required to be at the bottom of some existing holes about 20mm deep, hence drilling had to rely on the drilling machine measurement scale. My drilling machine is a NuTool CH10 which has many flaws, one of which being that the existing depth measuring facility is rather poor to say the least (**photo 2**). In particular, it has a linear scale with 1mm divisions spaced 1mm apart which means that with advancing years and ageing eyes, these divisions are becoming more difficult to read; the pointer is a piece of bent metal which is a push fit around the top of the screwed rod whilst its tip is best described as being blunt; the whole device is fastened at the lower end into a plastic clamp device, a part of the chuck guard, which is very insecure to say the least. In short, a most unsatisfactory arrangement, it being almost impossible to drill with any sort of accuracy.



Completed device.

A few months ago, I had occasion to use a friend's drilling machine and noticed that his machine had a rotary scale attached to the spindle between the handle and the rack and pinion quill mechanism. This was much easier to use and eliminated all the floppiness of the existing measuring mechanism. In addition, I realised that by using a larger diameter rotating scale, I could effectively magnify the distance between the 1mm graduations thus making it easier to read and increasing accuracy. Thus this project was born.



Original depth measurement system.



RHS of my drilling machine showing operating spindle and adjustment bolt with locking nut.



Paper scales & aluminium disc.

Design & Construction

The first thing to do was to find out just how much quill travel there was, and how it related to the operating spindle. I therefore mounted a rule in the vice and measured the amount of quill travel available: this turned out to be 59mm. Next I measured the amount of quill travel for one revolution of the handle: thus turned out to be 56mm. Now as it happens, depending on the adjustment of the screw just in front of the operating spindle (visible in **photo 3**), the first few millimetres were not particularly usable, (in fact Geoff Bartlett in MEW40 discusses just this problem) and so I decided that a rotary scale equivalent to 56mm would be satisfactory. I also reasoned that I should calibrate the scale at the 56mm position, i.e. with the quill fully extended. This happens to coincide with the zero position. This meant that the actual quill up zero position would be effectively -3mm i.e. 53mm. Which wouldn't matter at all.

The next thing was to find a suitable piece of material to form the rotary scale. This turned out to be a disc of re-melted aluminium (**photo 4**), complete with slag inclusions and hence not much use for anything else, measuring 16mm thick and 81.1mm in diameter. This gave a circumference of 254.78mm which divided by 56 gives approximately 4.55mm on the circumference to represent 1mm actual travel of the quill. I thought this to be a satisfactory magnification, especially as it also allowed for the possibility of marking the ½mm intervals. As this was to be both experimental and temporary, I thought I

would bore out the disc to make it a push fit onto the operating spindle thus allowing for easy adjustment and for corrections/replacement if necessary.

Finally, there was the problem of calibrating the rotary scale. Clearly it was going to be impossible to measure and mark, after all, with the best will in the world I am not able to measure every 2.275mm around a circular object. I therefore decided to draw the scale using CAD, print the scale onto paper and then glue the paper scale onto the disc. Using CAD would enable me to accurately mark all the divisions and to produce markings of the same length.

Problems abound

Unfortunately, things didn't go exactly to plan. For a start, the printing process somehow produced a scale which was about 1mm too short, hence the two ends did not meet when wrapped around the disc. Fortunately, within my CAD program there is the facility to scale a drawing for printing, so I arranged for the print to be scaled up by 1 in 254.78, ie 1.0039249. The resultant print was now correct and the two ends met as required. I also took the opportunity of increasing the size of the scale numbers and of making them bold.

Photograph 4 shows both these scales and whilst the numbers on the right hand scale are both bolder and larger, I rather think I may have overdone it. Once I was satisfied with the paper scale, I covered it with clear Sellotape for protection. The scale was then glued onto the disc using diluted PVA glue. This produced

two problems – one being that the wet glue allowed the print on the reverse side of the scale (I was using scrap paper) to bleed through and whilst this is not visible on the photo, it is visible as darkish patches on the disc. The second problem was that gluing the scale onto the disc appears to have caused the scale to shrink slightly. Unless, it is the thickness of the glue that needs taking into account.

Another problem was that I bored out the disc a shade too large so it was now no longer a push fit. Now a better method of fitting the disc to the spindle would be by using a pair of radial setscrews set 90° apart inserted into tapped holes from the circumference and bearing on the spindle via a pad of softish material. I did not do this as the whole device is meant to be experimental and temporary: I therefore jammed a suitable sized piece of thin plastic in the bore thus achieving the original idea of a push fit.

Finishing off

Finally, there was a need for a pointer. As luck had it, I had a small piece of steel sheet in the scrap box which only needed a hole drilling, a small amount of hacksawing and cleaning up followed by bending to produce a satisfactory pointer. I fastened the pointer under the locknut for the adjustment screw located just in front of the operating spindle.

Photograph 1, specially posed, shows the eventual result. As usual, check your own machine measurements as they will probably be different to mine. ■



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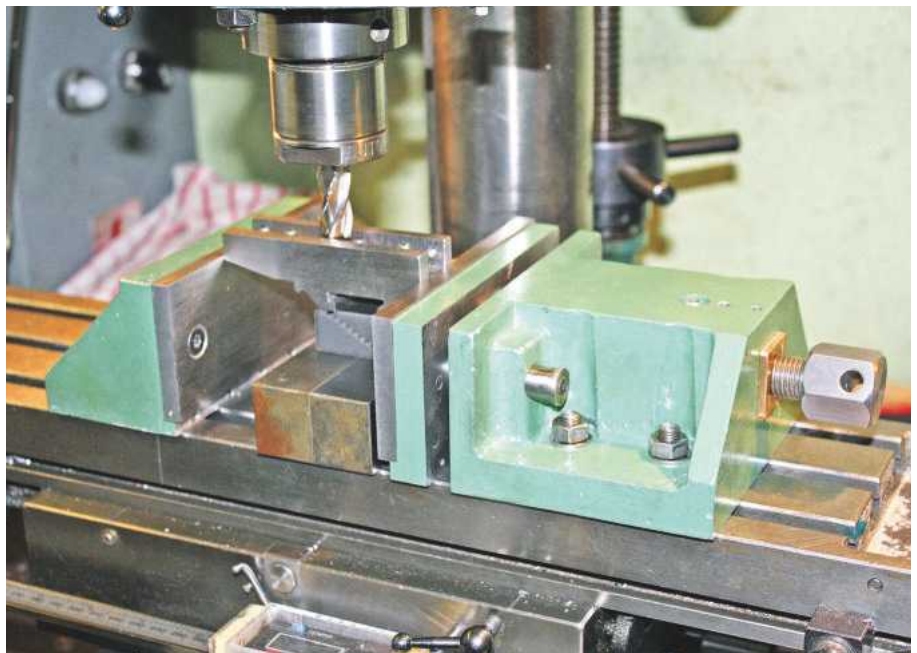
A Table Length Milling Vice

Part 3



In this series, with beginners in mind, David Piddington gives a step-by-step guide to machining a milling table vice of his own design. The castings and full size drawings for the vice are available from Hemingway.

The original concept of this vice was taken directly from similar commercially available ones which are too large for model engineers like myself who only have workshop space available for lathes such as the Myford Series 7 and smaller mills such as the Senior 'E', for which the two prototype vices were made. My own workshop measures 11½ by 7½-feet so storage and workspace comes at a premium.



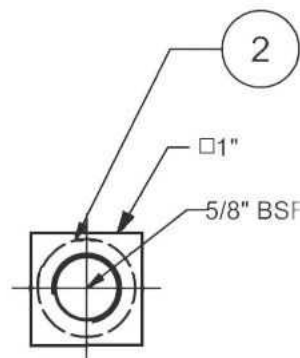
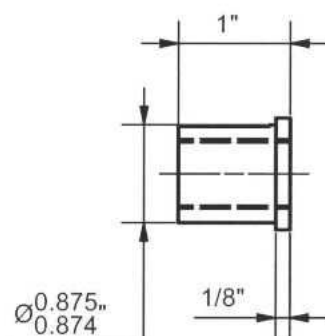
The toolbit – ¼ inch HSS steel not longer than ⅞ inches - should be at about 1 inch from the end and secured internally with a 2BA x ¼ inch grub screw impinging on a short piece of ⅝ inch diameter silver steel. This is because standard taps are not long enough to reach the tool bit. Support the

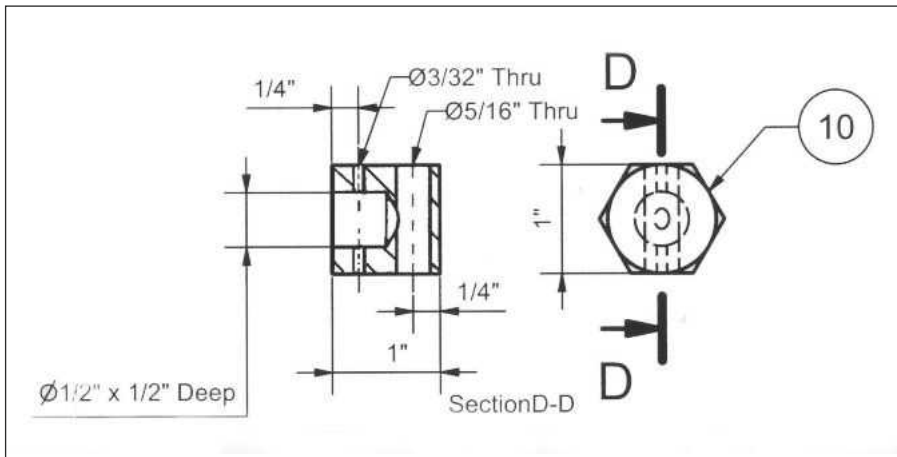
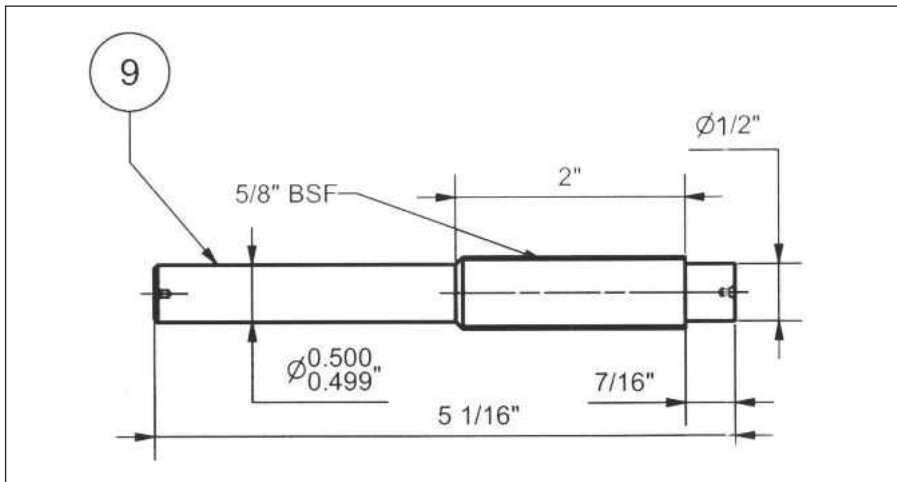
outer end with a live centre in the tailstock. The actual bore diameter is not critical but aim for ⅞ inches diameter. Also in the photo, a temporary depth stop is clamped to the lathe bed.

Clamp screw nut: This is supplied as a square-flanged gunmetal casting. Grip in the 4-jaw self centre chuck by the flange and set the round cast part to run approximately truly. Centre drill the end and then pass through in stages, up to the tapping drill size which for ⅝ inch BSF is 17/32 inches. Put your lathe into back-gear - I used the second slowest on my Myford S7 - with some lubricant - I use RTD - on a taper tap and let the tap cut right through the block. A 2nd or plug tap may then be passed through to ensure accuracy.

Photograph 48: For making the clamp screw assembly, the screw component can be machined from solid, or fabricated, the latter method being chosen. Firstly on the end of a length of ⅝ inch diameter steel bar put a ¾ inch length of thread to suit the nut as shown in this photo.

At this point I recommend my series of articles published in *Model Engineers Workshop* issues 147-152 'To Die For' wherein I described the manufacture of several sizes of pre-set holders for split





The alternative method is to screw cut the thread to suit the nut, or screw cut both, process of which have been adequately described elsewhere and I hope readers will excuse this diversion having achieved satisfaction as detailed above.

Photograph 49: shows the embryo square nut having been put on to the threaded bar stub and against the chuck jaws. It is being machined to a close push fit in the pre-bored hole in the clamp block. Photo 49A shows the obvious, facing the front of the nut flange. During the process of converting my drawings to CAD, a change was made to make it from round bar, but I observed that it would be unlikely to grip this in the small 4 inch chucks that we Myford users use and not have it revolve with the torque required to pass the tap though. I have therefore recommended this be changed to a flanged GM casting as above.

Photograph 49A: Grip the casting by the square end in the 4-jaw chuck, centralise the round part and centre drill the end. With a running centre in the tailstock machine the diameter to a light push fit into the end of the sliding jaw $\frac{3}{4}$ inch reamed hole, noting that a one thou' tolerance is given on the figure and to a length of $\frac{7}{8}$ inches. Drill and tap right through $\frac{5}{8}$ inch BSF which is core diameter is 0.5336 inches and the nearest drill size is a few thou' smaller at $\frac{17}{32}$ inches. A taper tap will probably cut through this but if this starts to strain your machine, stop at once and bore a few thou' out of the hole to suit to suit the diameter of the tap lead end. After tapping, remove the outer end burr, and put an internal chamfer on the end of the thread.

Reverse into your 3-jaw chuck face off the outer end to flange thickness of $\frac{1}{8}$ inch and put a similar to the other end chamfer on the thread. Finish off the square end by whatever means you have available remembering that in its prominent position it should look well. Total concentricity of the square to the round part is not vital here. Remove the outer burrs, but not those that will butt up against the casting.

For the clamp screw square off the ends of the supplied piece of $\frac{3}{4}$ inch diameter steel bar to $5\frac{1}{4}$ inches long putting a $\frac{3}{32}$ inch chamfer on the ends and also centre



threading dies. The bore to accept each dies is about $\frac{1}{64}$ inch (0.015 inches) diameter larger than the nominal diameter of the die. There are four grub screws at ninety degrees, one of which is coned to adjust the die within the holder. All screws act as a 4-jaw chuck allowing the die to be centralised within the holder and cut a thread accurately to desired diameter and fit within a nut. The standard diestocks fit commercial dies but do not allow for these to be adjusted to obtain a good fit of one with the other. It was a lot of work to make sixty plus holders, but has proved so, so worthwhile.



drill both ends BS2. Thread one end $\frac{5}{8}$ inch BSF to a length of 3 inches with your pre-set die, or screw-cut, as you prefer using the nut as the gauge. The remainder of the screw may now be completed turned between your lathe centres.

Photograph 50: Obtain, or make a split-clamp nut of the above size preferably in brass, say $\frac{3}{4}$ inch AF, and not more than $\frac{1}{2}$ inch long, which will be used to prevent the between centres catch plate driving dog from damaging the end. Set between the lathe centres and machine the plain end $2\frac{3}{4}$ inches long at 0.990 inch diameter, which process should just clean up the thread allowing it to be assembled though the clamp screw nut from this end. See **photo 50A**. Replace the end chamfer and adjust accordingly if required.

There is a third alternative method of obtaining that 'push' fit - crude but effective - by lightly knurling the short turned end of the clamp screw.

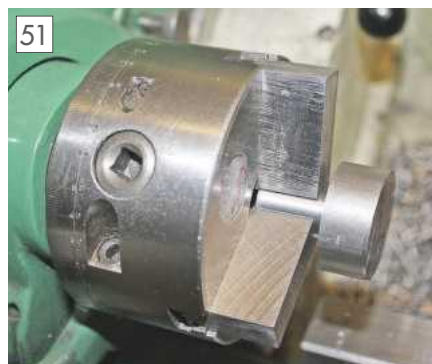
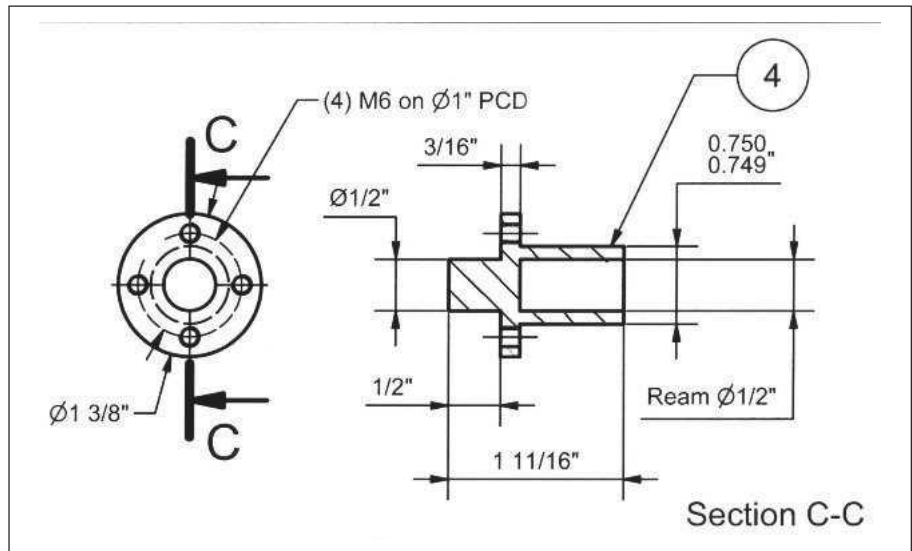
Photograph 51: For the clamp screw buffer a $1\frac{3}{4}$ inch length of $1\frac{1}{4}$ inch diameter mild steel is required. Turn the longer dimensioned end to 0.749 inches diameter for a length of 1 inch. Centre and drill in stages up to $\frac{3}{16}$ inches diameter with the point of the latter no deeper than $\frac{15}{32}$ inches deep, and then put the lead end of a $\frac{1}{2}$ inch reamer into the hole. Complete the hole to its full 1 inch depth with either a slot drill or square-ended twist drill.

Reverse in the chuck provided that yours is running accurately. If not use of soft chuck jaws is recommended, or if your lathe has a 'Griptru' chuck, take time to check that for this job it is running exactly concentric. You might even have a collet of this diameter, but for Myford users, this is not an option.

Complete the machining to the figure ensuring that the spigot fit into the locking jaw carrier is a close push fit.

Photograph 51 shows a 'Griptru' fitted with soft jaws due to a lazy operator wanting to speed up production.

Photograph 52: The clamp screw boss (see item 10), which is the 'thing' for turning the screw, face to 1 inch long a piece of 1 inch diameter mild steel, centre and drill from one end a square bottomed hole to a push fit over the stub, at to the same length as, the clamp screw as photo 52. 1 inch diameter will be supplied with the kit, but assuming you have a dividing head, a slightly smaller hexagon, say $\frac{7}{8}$ inch AF, can be made though I had an off cut of 1 inch hexagon in stock, which I used. Alternatively you may have a filing rest and can use this instead, indexed by the chuck jaws. A press fit would be better but a long stroke mandrel press is required, as the usual bench vice will not do this operation. Alternatively a shrink fit would be better still but this will require a lot of heat and discolouration of components, which will compel surface cleaning and polishing afterwards.



So after the boss has been surface finished to your satisfaction, initially secure it with 'Loctite' and allow for curing. That completed, at a point $\frac{5}{16}$ inches from the thread end of the boss, drill right through $\frac{3}{16}$ inch diameter and drive in a spring roll pin. As an alternative, if you have a $\frac{5}{16}$ inch taper pin reamer then use this method instead. At the time I didn't have roll pins large enough but did have a taper pin and the reamer for it. Taper pins are measured on the larger diameter (Ref. Kempe's Engineers Year Book 1990 Section E6/29), but you will need to measure the small end to calculate the drill diameter to give the maximum engagement



length before commencing reaming. Check that about, but not less than $\frac{1}{4}$ inch of the pin's large end is protruding before tapping home using a small hammer. Remove the excess and file flush before matching the surface finish to the same standard as the other faces.

There is a third alternative method of obtaining that 'push' fit - crude but effective - by lightly knurling the short turned end of the clamp screw. The boss will require careful hammering to fit it. Then continue with the roll pin, or taper pin, securing method.

To be continued...

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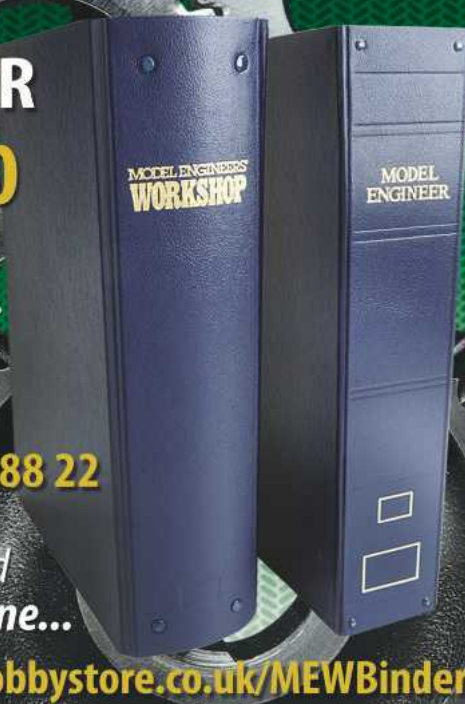
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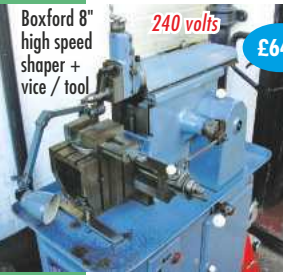
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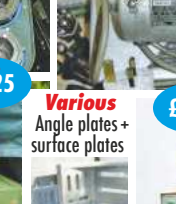
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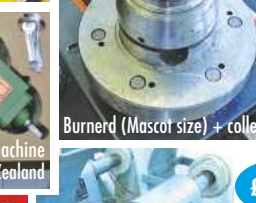
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